The Australian and New Zealand Journal of Surgery

JANUARY, 1933.

TABLE OF CONTENTS.

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PAGE

EDITORIAL NOTICES 226

ORIGINAL ARTICLES—

The Melbourne Hospital and the Development of Surgery in Victoria: An Historical Sketch ..... *B. T. Zwar* 227

The Value of Laboratory Investigations in the Diagnosis of Hydatid Infestation ..... *K. D. Fairley and C. H. Kellaway* 236

Toxic Goître ..... *H. Hume Turnbull and Alan Newton* 244

Osteochondritis, and in Particular Osteochondritis Dissecans *C. W. B. Littlejohn* 278

Rhabdomyoma of the Extremities ..... *P. MacCallum* 296

Mesenteric Embolism: Three Cases of Recovery *Julian Smith, Junior* 309

The Present Position of Spinal Analgesia ..... *B. T. Zwar* 315

SURGICAL TECHNIQUE—

The Technique of the Intravenous Administration of Blood and Physiological Solutions ... *I. Jeffreys Wood and C. Wallace Ross* 317

CASE REPORTS—

A Case of Hydatid of the Kidney ..... *Victor Hurley* 326

SURGERY IN OTHER COUNTRIES—

Damage to the Spinal Cord Following Spinal Analgesia and its Prevention 330

A Controllable Form of Spinal Analgesia which Allows of the Grading of the Dosage According to Individual Requirements .. 332

REVIEWS—

Anæsthesia 333

A Book on Orthopædic Surgery 334

PROCEEDINGS OF THE ROYAL AUSTRALASIAN COLLEGE OF SURGEONS—

New Zealand Meeting 335

Post-Graduate Travel Bureau 336

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THE MELBOURNE HOSPITAL AND THE DEVELOPMENT OF SURGERY IN VICTORIA: AN HISTORICAL SKETCH.

By B. T. ZWAR.

THE Melbourne Hospital was founded in 1846. On March 26 of that year its foundation stone was laid by James Palmer, a Member of the Royal College of Surgeons of England, who had come to Australia in 1840. In England he had occupied an official surgical position and had edited the works and written the life of John Hunter. In Australia Palmer practised his profession to a limited extent only and devoted himself to public affairs; he became Mayor of Melbourne in 1845, and the representative of Port Phillip in the Legislative Council of New South Wales in 1847. In 1851, he became a member of the first Legislative Council of Victoria, and on November 11 of that year was elected the first Speaker of that body; he retained this position until his death. St. James's Park, a portion of Hawthorn, where he resided, was named after him after his death. From its foundation, Palmer identified himself closely with the Melbourne Hospital; he was a member of the Committee of Management from its inception and, later, became its President and held this position until he died on April 23, 1871.

The dispute which occurred over the selection of a site for the Melbourne Hospital, and which recurred from time to time, without doubt would have been avoided had its foundation been preceded by that of the Medical School of the University of Melbourne. The University of Melbourne, however, was not founded until 1855, and the first lectures in its medical curriculum did not commence until 1862, whilst the first buildings of the Medical School were not completed until 1864. Shortly after the opening of the buildings of the Medical School, namely, in 1865, there commenced the first movement for rebuilding the Melbourne Hospital on a site in closer proximity to the Medical School.

Readers of this journal, however, will be interested more in the part played by the Melbourne Hospital in the development of the practice and teaching of surgery in this State. In any historical review of the practice of surgery in the Melbourne Hospital, it is desirable to bear in mind the fact that Lister did not publish his epoch-making communication, "On a New Method of Treating Compound Fracture, Abscess, etc., with Observations on the Conditions of Suppuration", until March, 1867. As elsewhere, in those early days of the Melbourne Hospital, the practice of surgery was beset with dangers which were not understood, and the field of surgery was limited.

James Palmer.

The first noted surgeon of the Melbourne Hospital was David John Thomas, who for eight years prior to the opening of the Hospital and whilst its present site was still bush, had been one of four medical officers who had charge of twenty hospital beds, accommodated in an unpretentious structure, lent by J. P. Fawkner, situated at the western end of Bourke Street. Thomas was noted for the zealous and conscientious way in which he discharged his hospital duties. He was a frequent and noted contributor on professional subjects to the Medical Society and to *The Australian Medical Journal*, which had been founded in 1855. Thomas, indeed, was the first to read a paper before a medical society in Port Phillip. This was in 1847 before the Port Phillip Medical Society on "The Inhalation of the Vapour of Ether, with Cases". Morton had carried out, in 1846, the first operation, an extraction of a tooth, using ether as an anæsthetic. Notwithstanding the slowness of communication in those days, Thomas in his paper showed that he had familiarized

himself with all the researches which had been carried out in regard to the use of ether.

As evidence of the limitations of the field of surgery in those days, the following extract from Thomas's address as retiring President of the Medical Society of Victoria, and delivered on January 11, 1865, is of interest. He stated:

> The formidable operation of ovariotomy . . . . may be considered a legitimate proceeding in modern surgery . . . . but the diagnosis of cases suitable for its adoption is avowedly a point of great difficulty, and the management of a patient after operation can be trusted only to the most experienced hands. To these remarks, it may be added, that many patients sink from the mere shock of the operation, and others from secondary causes which are not yet very well understood.

Notwithstanding the limited field of surgery, the fortnightly reports of the Medical Superintendent of the Melbourne Hospital to the Committee of Management regularly enumerated the cases of erysipelas and pyæmia which had developed amongst patients whilst in hospital as a result of causes not then understood.

Thomas died on June 1, 1871, at the age of fifty-eight years. His last communication appeared in the last issue of *The Australian Medical Journal* prior to his death. The paper dealt with the amputation of a thigh and a discussion on the relative value for arresting hæmorrhage of the catgut ligature steeped in carbolic acid, as recommended by Lister, and the acupressure needle, advocated by Simpson. From Thomas's expressed opinion, it is clear that he had failed to appreciate the importance of Lister's teaching both in regard to hæmostasis and sepsis.

In 1851 Thomas had been joined on the surgical staff of the Melbourne Hospital by Edward Barker, a Member of the Royal College of Surgeons of England (he was admitted to the Fellowship of the College in 1859). Barker had come to Australia in 1840, but had at first devoted himself to pastoral pursuits. As a student, Barker had been a dresser to Liston in University College Hospital, London, and when, in 1849, he settled in Melbourne and commenced the practice of his profession, he soon gained the reputation of a skilful operating surgeon. In 1864 Barker was appointed the first Lecturer in Surgery in the University of Melbourne, and held this position until 1880. Barker is described as a sound and cultured lecturer; he was intimately associated with the formation of the Medical Society of Victoria in 1855, was an assiduous collector of medical books, and possessed one of the most complete medical libraries of his days. Thomas Naghten Fitzgerald expressed the opinion that in his prime Edward Barker was the best surgeon in Melbourne.

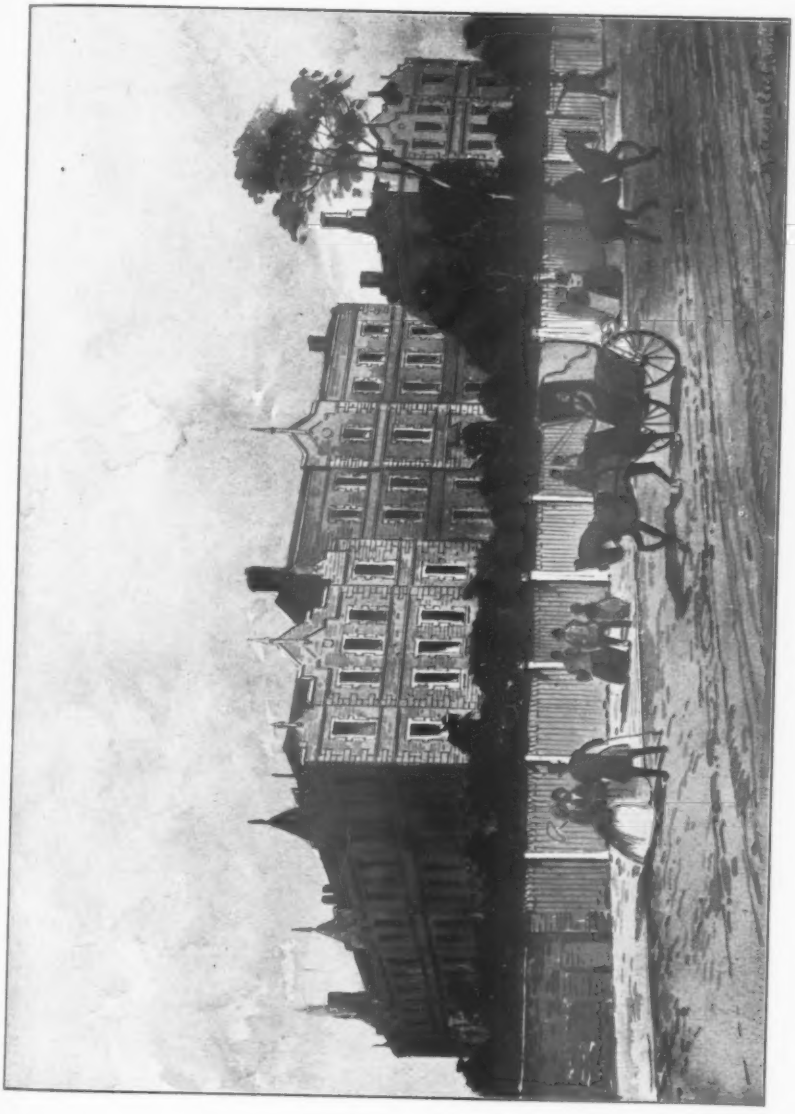
Two years after Barker's appointment to the Melbourne Hospital, namely, in 1853, there was elected to the surgical staff of that institution William Gilbee, a Member of the Royal College of Surgeons of England. Gilbee had come to Melbourne in 1849, but had immediately left our shores in one of the gold rushes to the western states of North America.

After tiring of the roughness and wildness of that adventure, he had returned to England, but had forthwith joined the *Georgiana*, carrying adventurous spirits to the goldfields of Bendigo and Ballarat. Gilbee played an important part in the development of the Melbourne Hospital. During his association with the institution, the daily average of patients in the hospital increased from about 40 to 342. Many medical graduates of the University of Melbourne will remember a contemporary of Gilbee, James Edward Neild, that able *littérateur*, scholar, dramatic critic and Lecturer on Forensic Medicine. Neild, writing of Gilbee in 1885, said that:

> The growth of the Melbourne Hospital is indissolubly associated with the name of William Gilbee, and in any record of its history, it will be impossible not to connect him with it.

Gilbee is described as an eminently practical surgeon, with a clear head and a large share of common sense, and as one who made few mistakes in diagnosis. His early recognition of the importance of Lister's teaching is lasting evidence of the soundness of his judgement. Lister's first communication on the treatment of suppuration appeared in *The Lancet* of March 16, 1867, and on December 4 of that year, before the Medical Society of Victoria, Gilbee reported "two cases illustrating the treatment of abscess and compound fracture by Mr. Lister's new method". In the course of his remarks, Gilbee referred to Lister's work as "one of the most important discoveries in modern surgery". Compare this judgement with that described by Watson Cheyne as existing in London when Lister migrated there in 1877: "The number of London surgeons who were using his [Lister's] methods or were impressed by his teaching was extremely small, and could probably be counted on the fingers." In addition to his work on the surgical staff of the Melbourne Hospital, Gilbee became a member of its Committee of Management, a Vice-President in 1879 and President in 1882.

At the Melbourne Hospital the credit of first establishing the soundness of Lister's teaching belongs to Tharpe Mountain Girdlestone, a Fellow of the Royal College of Surgeons of England. Girdlestone, after a varied career as a coroner on the goldfields, a member of the Legislative Assembly and Health Officer of the City of Melbourne, had been appointed Assistant Surgeon to the Melbourne Hospital in November, 1876. He succeeded Barker as Lecturer in Surgery at the University of Melbourne on December 2, 1880, and was appointed Surgeon to In-Patients at the Melbourne Hospital in 1883. *The Australian Medical Journal* of July 15, 1887, contained the report of a series of operations carried out by Girdlestone and followed by primary healing. These operations, which included an opening of the knee joint and the amputation of the forearm, were reported by Girdlestone's House Surgeon, Dr. John F. Wilkinson. They are the first records of such healing in Melbourne, and Girdlestone continued to secure such results with almost unfailing regularity. Girdlestone's name is associated also



The Melbourne Hospital, 1862.

with the introduction and strong advocacy of the kangaroo tendon as a ligature. His lectures are described as sound and up to date.

Girdlestone resigned his lectureship in surgery at the end of the first term of 1895. His successor, Frederick Dougan Bird, was appointed on April 29, 1895, and was a graduate and Master of Surgery of the University of Melbourne. Whilst contemporary literature marks Gilbee and Girdlestone as two Melbourne Hospital surgeons who made important contributions to the advance of surgery in Victoria, the equally, if not more, important part played by two of their contemporaries, Edwin Matthews James and Thomas Naghten Fitzgerald, must not be overlooked.

James, the son of a Church of England clergyman, had had his medical training interrupted on account of financial difficulties. He had come to Australia to seek his fortune on the Victorian goldfields. Failure to achieve this objective had led him to accept an appointment as dresser and dispenser at the Melbourne Hospital in 1853. In 1858 he returned home to complete his medical studies, and was admitted a member of the Royal College of Surgeons of England in 1860. On his return to Australia he was appointed an Assistant Surgeon to the Melbourne Hospital in 1861 and a Surgeon to In-Patients in 1865. He proved himself a most able and careful surgeon, painstaking to an extreme degree, and possessed outstanding mechanical ability. He is remembered for his influence as a teacher and for the personal interest in his students. He resigned his position at the Melbourne Hospital and returned to England in 1890 and died at Melrose, in the south of Scotland, on July 7, 1900.

Thomas Naghten Fitzgerald is still remembered as the most notable figure of all the leaders of his days in the medical profession in Australia. Born in Ireland on August 1, 1838, he received his medical education in Dublin, where he acted as dresser for the celebrated Dublin surgeon, Mr. Butcher. He became a Licentiate of the Royal College of Surgeons of Ireland in 1857 and came to Melbourne in 1858. Soon after his arrival, he was appointed House Surgeon to the Melbourne Hospital. In 1860 he was elected full Surgeon to that institution. His appointment to such a position at the age of twenty-two marked an early recognition of that genius and surgical skill which he possessed, and which marked his work throughout his professional career. Though of medium height, Fitzgerald possessed a commanding presence, and it was natural to recognize him as a person of importance. He was a brilliant operator and keen observer. Before the publication of Lister's researches, he had been deeply impressed by the difference in the course and the dangers of simple and compound fractures. In order to avoid the then unexplained risks of surgical infection, he had devised a whole series of subcutaneous operations in which his fine touch, precision and neatness found full expression. For similar reasons, he had devised an operation for the cure of inguinal hernia by the subcutaneous introduction of a gold wire suture. His originality also found expression in

special operations for talipes, cleft palate, lengthening of tendons, treatment of neuralgia by injections, and many other forms of treatment which subsequently became established. Fitzgerald's brilliance and

Thomas Naghten Fitzgerald.

dexterity as an operator were surpassed only by his soundness as a diagnostician. As his House Surgeon, the writer had the privilege of appreciating the outstanding personality and greatness of this brilliant

The Melbourne Hospital, 1932.

surgeon. Right through his professional career, he identified himself with the work of the Melbourne Hospital, and never wavered in his advocacy for its removal elsewhere.

Fitzgerald was the first teacher in clinical surgery appointed by the Council of the University in the Melbourne Hospital, and his influence on the development of surgery in Victoria was tremendous. Syme voiced the opinion of his students when he said that "to his teaching, his help, and his example he owed more than he could ever express".

Thomas Naghten Fitzgerald was the President of the Section of Surgery of the first Intercolonial Medical Congress held in Australia in 1887. He was knighted in 1897. He died on July 8, 1908, and it was universally acknowledged that his passing removed the most notable figure that yet had graced the medical profession in Australia.

The traditions laid down by the foregoing were carried out well by the succeeding group of Melbourne Hospital surgeons, outstanding amongst whom were Bird, Moore, Rennie and Syme. These men appreciated thoroughly the principles of asepsis, and the inter-relationship of anatomy, physiology, pathology and surgery. Though they have passed, their names remain as household words and their influence upon the art and practice of surgery is sufficiently recent to be remembered by most.

The foregoing presentation of an historical sketch of the earlier influence of the Melbourne Hospital upon the development of the art and practice of surgery in Victoria is based mainly upon the information supplied by contemporary literature. In its arrangement the writer has been guided by one of the ideals of the late William Osler, namely, that the great possession of a teaching hospital, such as the Melbourne Hospital, is its great names.

> It is not the pride, pomp and circumstance of an institution which brings honour, nor its wealth, but the men who have trodden in its service the thorny road through toil, even through hate, to the serene abode of Fame, climbing "like stars to their appointed height".

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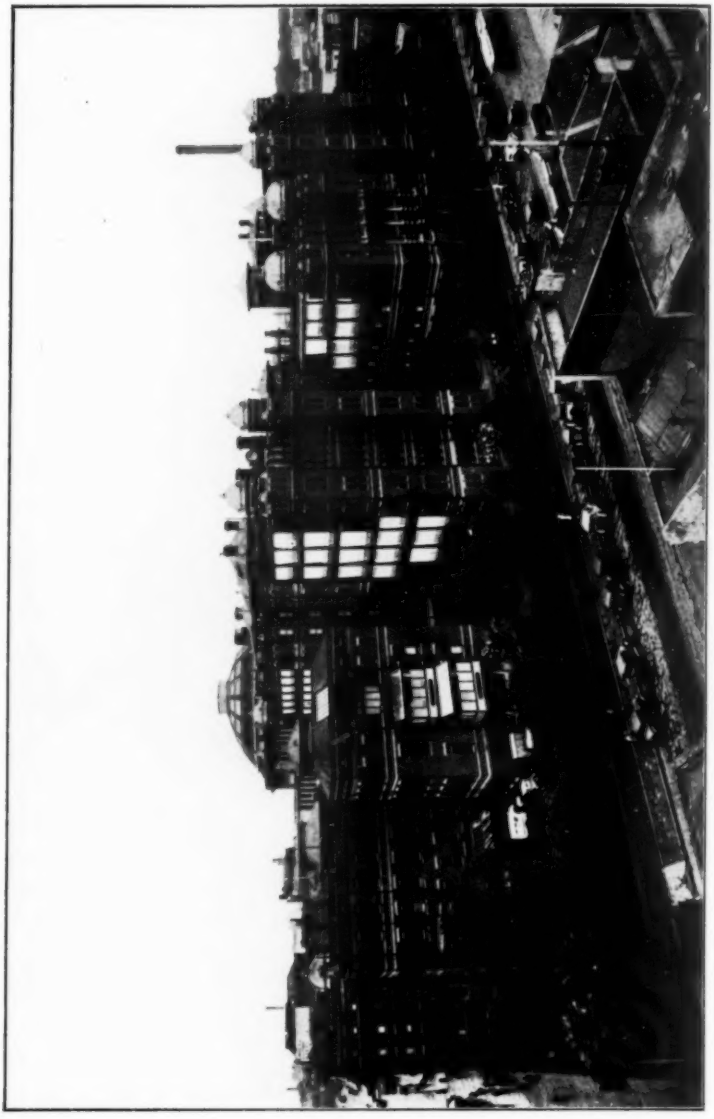

The Melbourne Hospital, 1932.

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"Joseph, Baron Lister: Centenary Volume."

THE VALUE OF LABORATORY INVESTIGATIONS IN THE DIAGNOSIS OF HYDATID INFESTATION.

By K. D. FAIRLEY,
Physician to Out-Patients, Melbourne Hospital;

AND

C. H. KELLAWAY,
Director of the Walter and Eliza Hall Institute.

[From the Walter and Eliza Hall Institute.]

BEFORE the discovery and standardization of serological and skin tests, the pre-operative diagnosis of hydatid disease was much less accurate than it is today. At the Melbourne Hospital, in a period of fifteen years immediately preceding the use of these tests, the error in pre-operative diagnosis in 224 patients with this disease was 56·3%. Among 133 patients who were fully investigated between 1924 and 1930 the error in diagnosis was only 4·7%. During this period there were 17 patients who for various reasons were not so investigated, and in none of these was the condition diagnosed.

Before the complement fixation test was thoroughly studied and standardized by N. H. Fairley[1] in 1922, the only laboratory tests carried out here were the microscopic examination of hydatid material obtained more or less fortuitously and the investigation of the blood for eosinophilia.

Although the discovery of laminated membrane, scolices or hooklets in discharges from the patient make the diagnosis certain, they are found somewhat infrequently. None the less, they should be sought in the fæces whenever the symptoms suggest the rupture of a cyst into the biliary passages. They should not be overlooked in the sputum, in specimens of pus and in the urine.

Occasionally a fluid obtained by aspiration proves to be of hydatid origin, but diagnostic puncture of a suspected hydatid cyst is contra-indicated because of the risk of sowing further cysts, particularly in the peritoneum and musculature, and, in the case of cysts of the lung, because of the danger of causing rupture into a bronchus and asphyxial death. Serious general allergic symptoms may occur following puncture, but these respond to the injection of adrenalin. Hydatid fluid, apart from the presence of hooklets or scolices, may be recognized by its clear limpid appearance, its small content of coagulable protein and

its content of sodium chloride (about 0·6%). It may be differentiated from cerebro-spinal fluid by the absence of any appreciable quantity of glucose and urea. The result of a test of its antigenic properties, if positive, makes its identification certain, though fluids from barren cysts are non-antigenic.

The occurrence of eosinophilia in many diverse conditions impairs its diagnostic value in hydatid disease. In about one-half of those harbouring hydatid cysts, a count of more than 300 eosinophile leucocytes per cubic millimetre of blood is found before operation, while in about one-third of these patients the eosinophile cells exceed 500 per cubic millimetre. Occasionally very high counts are seen, the eosinophile cells exceeding 10,000 per cubic millimetre and even outnumbering the neutrophile leucocytes.

Rarely, a moderately high eosinophilia may be found in a patient in whom the serological tests for hydatid disease are inconclusive. When the common causes of eosinophilia (such as asthma, chronic skin disease and intestinal worms) can be excluded, an increase in the eosinophile cells in any patient whose clinical condition suggests hydatid infestation is significant.

SEROLOGICAL TESTS.

The Precipitin Test.

The results of the precipitin test, which was improved by the use of a carbolized hydatid fluid as antigen,[2] correspond closely to those of complement fixation, but we no longer use it because of the difficulty of reading the end point when a very fine precipitate is present.

The Complement Fixation Test.

The technique of the complement fixation test, as used here, is that laid down by N. H. Fairley.[1] The extensive literature on this subject was reviewed by Hiles[3] in 1926. Most observers record positive findings in from 70% to 90% of patients with hydatid disease, though many make no differentiation between those tested before and after operation. An analysis of the results of this test was presented in this journal by Fairley and Williams[4] in 1930. The figures used in the present discussion combine these results with those originally published by N. H. Fairley.[1]

Positive findings were obtained in 152 (65·5%) of 232 patients tested before any operation for hydatid disease. In some fifty of them no operation was performed. Positive results were obtained in 60% of those in whom the diagnosis was confirmed by the surgeon, and also in 60 (68%) of 88 patients before further operation for residual or recurrent cysts.

That the pathological condition of the cyst strikingly influences the results of the test is shown in Table I, which comprises results obtained in patients with residual or recurrent cysts as well as in those tested prior to their first operation for hydatid disease.

This table illustrates the influence of factors affecting the absorption of antigen from the cyst. The pathological condition of the cyst has been determined from the hospital records of the operative findings, described in varying detail by different observers. Sometimes a cyst has been regarded as degenerated merely because there was a deposit of calcium salts in the adventitia, while such a cyst, provided that its contents appeared normal, might well have been classified as uncomplicated. Similarly there is sometimes difficulty in differentiating suppuration and degeneration. The presence of cysts other than the one under consideration may account for an occasional unexpected result.

In a number of instances where the cyst has been classed in the hospital records as uncomplicated, some leakage of fluid has doubtless occurred, for example, into the biliary passages from certain hepatic

TABLE I.

Results of the Complement Fixation Test in Relation to the Pathological Condition of the Cyst.

Pathological Condition of the Cyst.	Positive Results.	Failure to React.	Total.
Uncomplicated	55	48	103
Recent Rupture (Incomplete)	32	2	34
Recent Suppuration	44	2	46
Old Rupture (Complete)	1	16	17
Chronic Suppuration	0	4	4
Degeneration	11	38	49
Total	143	110	253

cysts. It appears probable that little or no antigen is absorbed by the host from a truly uncomplicated cyst. This explains the frequent failure to obtain positive findings in hydatid infestation in childhood. When the serum of a patient not previously subjected to any operation for hydatid disease, fixes more than six minimal hæmolytic doses of complement, it is highly probable that rupture or suppuration of the cyst has occurred. These complications lead to a great increase in the absorption of antigen during a short period. One of the two patients with recent rupture of a cyst, whose serum failed to react when tested soon after the accident, showed a positive result when retested a fortnight later before any operation was performed. In the other patient, the cyst fluid may have lacked antigenic properties. In the two cases of recent suppuration in which positive results were not obtained, the cysts had apparently degenerated long before they became infected.

Lack of absorption of antigen during some months accounts for the failure to react in instances of death of cysts following rupture or chronic suppuration. In the only instance where a positive result was obtained, the patient was presumably harbouring other cysts. In three

cases included under the heading of "old complete rupture" the cyst had opened into a bronchus more than ten weeks before the test. The complete evacuation of the cyst contents to the exterior accounts for this result, which does not follow rupture into the pleural or peritoneal cavities. This corresponds with the frequent finding that within ten weeks of operation on a cyst a positive result may no longer be obtained. In all the other cases included in this group rupture had occurred some years before the test.

The available data are not sufficient to allow a similar division of the cysts classed as degenerated into recent (incomplete) and complete. In cases of commencing degeneration of the cyst, a positive result may still be obtained; with complete degeneration, when antigen has not been absorbed during some months, the serum fails to react. In the first four days after operation on a cyst, failure to obtain a positive result is the rule in patients whose serum failed to react before operation. If the cyst is dealt with in such a manner that no absorption of antigen occurs during or shortly after operation, no rapid alteration takes place in the complement fixing titre of the serum, which gradually falls during the next few months, unless there is absorption of antigen from residual cysts. When extra antigen is absorbed as the result of incision and drainage of the cyst, a rise in the titre of the serum is usually manifest by the fifth day. In these patients a positive result is almost invariably present for at least one and usually for about three months after operation, the rare exceptions being in cases in which before operation the antigenic content of the cyst was already waning as the result of chronic suppuration, complete rupture or degeneration.

These facts show that failure to obtain a positive result is usually due to insufficient absorption of antigen during a short period before the test. This occurs with many uncomplicated cysts, in completely degenerated cysts and in cysts which have completely ruptured or suppurated a long time before. In rare instances, the cyst fluid possesses no antigenic properties.

If the serum of a patient fixes six or more minimal hæmolytic doses of complement (P + + + reaction) nine months or more after an operation for hydatid disease, or four and a half minimal hæmolytic doses more than a year after operation, one or more cysts are still present. The persistent fixation of three minimal hæmolytic doses of complement does not possess this significance, unless more than two years have elapsed since operation, though its occurrence more than nine months after operation is suggestive. Evidence of the greatest value for the diagnosis of persistent or recurrent infestation may be obtained by determining the amount of complement fixed by the serum of the patient in the third week after operation, when the titre of the serum is usually near its maximum, and by repeating this test at intervals of three or four months for a year and at longer intervals after this.

A positive result with this test is diagnostic of hydatid infestation. In 1,985 cases with no evidence of hydatid disease, a strongly positive

(P+++) result was obtained only in one instance, and was due to faulty labelling of the specimen. In nine others the serum of the patient was found to fix three minimal hæmolytic doses of complement on one occasion, but repetition of the test in six of these failed to confirm this finding. The serum of the other three was not retested. The fixation of four and a half or more minimal hæmolytic doses of complement by the serum of a patient is regarded as a positive result, as is the fixation of three minimal hæmolytic doses, provided it is confirmed on repeating the test with another sample of the serum.

It is obvious from the figures already presented that failure of the serum to react in this test before operation is of no value in excluding either primary or recurrent hydatid infestation. It does, however, exclude recent rupture or suppuration, except in those rare cases in which the cyst contents are not antigenic, or in which complete degeneration of the cyst has preceded the onset of suppuration.

The Intradermal (Casoni) Test.

Pooled hydatid fluid, sterilized by filtration, is the reagent usually employed in the intradermal (Casoni) test. It is generally derived from uncomplicated scolex-containing cysts of sheep.

Care in technique and in interpretation is necessary to obtain reliable results. This aspect of the subject was recently reviewed.[5] About 0·25 cubic centimetre of the fluid is injected intradermally in the skin of the lateral aspect of the upper arm, to raise a white area approximately one centimetre in diameter. If the patient has been tested on a former occasion, it is essential to infiltrate an area of skin away from the site of the previous injection to avoid the possibility of a fallacious response from local sensitization. A similar injection of normal saline solution (0·9%) a few centimetres away is used as a control. The flexor surface of the forearm is stroked moderately firmly with a blunt instrument, and if swelling and wheal formation occur along the line of the stroke (factitious urticaria) instead of the normal response (a red line followed within half a minute by a spreading flush), an immediate response to the intradermal test is without significance.

The Immediate Response.

An immediate response is shown by fading of the wheal, caused by the saline solution, while that from the hydatid fluid enlarges, usually showing pseudopodial outrunners, and becomes surrounded by an erythematous zone. The reaction reaches a maximum within half an hour and then disappears rapidly. The size of the wheal is measured by taking two diameters at right angles to one another, one being the maximum diameter measured from the end of one outrunner.

The test should be repeated if a doubtful result is obtained. In a doubtful response both diameters of the hydatid wheal measure from 2·0 to 2·2 centimetres or one diameter is less than 2·0 centimetres, while

the other lies between 2·2 and 2·4 centimetres. If the wheal from the saline solution is of this size, no reliance can be placed on a positive result with the hydatid fluid. Positive results show wheals of larger size than the above measurements, while wheals of smaller size are interpreted as failures to react.

A positive result may be found in patients who are or have been infested with other helminths and, in these circumstances, such a result is of no significance in the diagnosis of hydatid disease. The very rare instances in which a patient shows a positive response to the injection of hydatid fluid derived from sheep because he is sensitive to sheep serum protein, are easily identified by observing the result of an injection of dilute sheep serum. In these cases, hydatid fluid obtained from another host must be used.

TABLE II.

Preoperative Reactions in Relation to the Pathological Condition of the Cyst.

Pathological Condition of the Cyst.	Immediate Reaction.		Delayed Reaction.	
	Patients Examined.	Positive Result.	Patients Examined.	Positive Result.
Uncomplicated	20	16	15	7
Degenerating	15	11	10	7
Ruptured	17	15	11	5
Suppurating..	10	10	16	2
Total	62	52	52	21

Some fallacious responses have been recorded in patients with pruritus, urticaria, angioneurotic œdema, generalized skin disease, hay fever and asthma. When any of these are present, the greatest care must be used in the interpretation of results. A positive result is of diagnostic value only in patients who have never been submitted to any operation on an hydatid cyst. In such cases, this response is found in about 75% of those with cysts that are classed as uncomplicated or degenerating; while it is invariably present in cases of recent rupture or suppuration of the cyst, except in those in which the rupture has been followed by a generalized urticaria or in the rare instances when the cyst contents lack antigenic properties.

In Table II the results of the test in patients before their first operation for hydatid disease are shown in relation to the pathological condition of the cyst. In the two patients with ruptured cysts who failed to react when tested from two to three weeks after rupture, a generalized urticarial rash had resulted from this complication.

Failure to respond to the test is seen in patients whose cysts possess no antigenic properties. This occurs with barren cysts and may be

found when death of a cyst has taken place long before the test, or when complete rupture with evacuation of the cyst contents to the exterior, for example, after rupture into a bronchus, has occurred a long time previously. It also is seen for a few weeks after rupture of a cyst which has been followed by a generalized urticarial rash. Such a result years after an operation for hydatid disease in a patient formerly showing a positive result may reasonably be interpreted as an indication of cure or of degeneration of any cysts that are present. When the test is done as a routine on every patient in whom hydatid infestation is suspected, failure to react will correctly indicate the absence of the disease in at least 95% of cases. A positive result has no significance in the diagnosis of recurrent or residual cysts.

The Delayed Response.

At the site of the injection of hydatid fluid an area of erythema with subjacent induration may appear within a few hours. It usually persists for at least twenty-four hours, about which time the result is generally observed. Occasionally extensive reactions involving the whole upper limb suggest the diagnosis of erysipelas or cellulitis, but there is no fever, no toxæmia and no glandular enlargement. To be interpreted as a positive response, the area of infiltration and œdema about the site of injection of the fluid should be not less than four centimetres in diameter, no induration being found around the site of the control injection of saline solution. Infestation with other helminths and sensitization to sheep serum protein should be excluded when a delayed response is present.

The delayed response should always be observed, though the only two instances in which it was present without an associated immediate reaction, were in patients with cysts in muscles. Before the first operation for hydatid disease the delayed response is present in only about 50% of patients with uncomplicated or degenerating cysts, while it is much less frequently seen in those with ruptured or suppurating cysts (Table II). Though its presence under these conditions is valuable evidence of hydatid infestation, its absence is of no significance. It is of no value whatever in the diagnosis of the presence of further cysts in any patient who has been subjected to some operation on a hydatid cyst.

SUMMARY AND CONCLUSIONS.

1. The identification of hydatid membrane, scolices or hooklets in discharges from a patient is pathognomonic of hydatid infestation, but it is comparatively seldom that the diagnosis can be made in this manner.

2. An eosinophilia is present before operation in about half of the patients with hydatid disease, and this should be looked for in every patient suspected of suffering from hydatid disease.

3. A positive result with the complement fixation test before the first operation on any cyst is definite evidence of hydatid disease. Its

greatest value is in the diagnosis of recurrent or residual cysts in patients who have been operated on previously for hydatid infestation. The skin tests are useless for this purpose. The persistent fixation of six minimal hæmolytic doses of complement for more than nine months, or of four and a half minimal hæmolytic doses for more than a year, or of three minimal hæmolytic doses for more than two years after operation is diagnostic of further infestation. Failure to react with this test does not exclude the presence of hydatid infestation.

4. If due care is paid to technique and interpretation of the test, the immediate response to the intradermal injection of hydatid fluid is valuable evidence of hydatid infestation in any patient never previously operated on for this disease. It is of no value in the diagnosis of recurrent or residual cysts if the patient has at any time (at least within the previous ten years) been subjected to such an operation. Failure to react to this test will correctly indicate the absence of hydatid infestation in at least 95% of cases.

5. A positive delayed response is found in not more than half of the patients suffering from hydatid disease before their first operation for this disease, but when present it is valuable evidence of this infestation. It is useless in diagnosis once a patient has been operated on for this disease. Failure to react is of no value in excluding hydatid infestation.

6. The intelligent use of these tests doubles the accuracy of the pre-operative diagnosis of hydatid disease.

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TOXIC GOITRE.

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Introduction.

The joint authorship of this paper is due to the fact that the writers are in charge of corresponding medical and surgical wards in the Melbourne Hospital and have, therefore, collaborated in the treatment of those patients with toxic goître who have been admitted to these wards. They have also been associated in the treatment of many patients of this type in their individual private practices.

There are many unknown factors in this disease and, in consequence, it seems almost unnecessary to explain that the views expressed in this paper differ in some respects from those thought to be true even one year ago, just as they will almost certainly differ from those which may be cherished one year hence. The attitude of mind of those charged with the care of patients suffering from toxic goître has been best described by Bridges in "The Testament of Beauty":

> We sail a changeful sea through halcyon days and storm
> and when the ship laboureth, our steadfast purpose
> trembles like as the compass in a binnacle.
> Our stability is but balance, and conduct lies
> in masterful administration of the unforeseen.

It is, therefore, desirable to explain that, if a note of dogmatism is detectable here and there in this paper, it has been introduced solely to achieve a greater clearness of expression of the authors' present views on certain of the more interesting problems presented by this disease.

Material.

Though it is not proposed to give an exhaustive statistical analysis of a series of cases, as such studies are frequently misleading, brief references will be made to the complications and results in a consecutive series of 348 cases of toxic goître treated by thyreoidectomy during the last eight years by one of the authors (A.N.). Care has been taken

to exclude an additional 175 cases in which the toxic signs were slight or absent. It will thus be observed that the ratio of toxic to non-toxic or slightly toxic goîtres was 2 : 1.

CLINICAL CLASSIFICATION.

The term "toxic goître" is used to embrace all cases in which signs and symptoms of hyperthyreoidism or dysthyreoidism are present. The majority of these cases can be classified into definite clinical groups, though transitional cases, which do not conform to any particular type, frequently occur. Unhappily, apart from the frank exophthalmic type, about which there is no dispute, there are differences of opinion concerning both the nomenclature and pathology of these clinical groups. For example, those cases in which an enlarged and nodular thyreoid gland is found with symptoms of hyperthyreoidism, but in which the eye signs are slight or absent and the more severe nervous and gastro-intestinal symptoms are not a feature, are classified by Plummer[1] as "toxic adenomatosis" and by Dunhill[2] as "secondary toxic goître". Both these titles are unsatisfactory, and they are replaced in this paper by the term "nodular toxic goître". This type of goître may follow medical treatment of an antecedent exophthalmic goître, or it may occur in patients who have a nodular or colloid enlargement of the thyreoid without exhibiting previous acute symptoms. In addition to the exophthalmic and nodular types of toxic goître, there are some cases in which hyperthyreoidism is associated with a "single lump" in an otherwise normal gland. Though the pathology of this type of case is open to debate, it is probably different from that of nodular goître, and such cases should, therefore, be placed in a separate clinical group.

The clinical classification adopted is as follows:

1. Exophthalmic goître.
2. Nodular toxic goître.
   (*a*) Following exophthalmic goître.
   (*b*) Without antecedent acute symptoms.
3. The toxic single lump.

A summary of the symptoms and signs found in the various clinical groups enumerated above is necessary to explain and, perhaps, to justify this classification. It is, however, given with apologies, as it necessarily involves the repetition of much that is common knowledge.

1. *Exophthalmic Goître.*

Exophthalmic goître is a disease in which hyperplasia occurs throughout the gland tissue. The onset is usually comparatively acute, and the condition is characterized by the presence of eye signs, either exophthalmos or, more frequently, stare, associated with nervousness, increased metabolism with elevation of the basal metabolic rate, sweating, loss of weight despite an increased appetite, and a rapid heart beat. Gastro-enteric upsets are common and acute thyreotoxic crises, sometimes the first indication of the disease, may occur. The nervous symptoms are

much more prominent than the cardiac symptoms, and gross arrhythmias are not common except in the later stages of the disease or immediately after operation. Drugs of the digitalis group have little or no effect in slowing the heart rate, though this is rapidly effected by iodine, if the patient reacts to this drug. The myocardial damage produced by the thyreoid toxin is slight, at least until it has acted over a prolonged period. The diagnosis of this disease is usually easy, and there is no doubt that surgical treatment, to be effective, must consist in an almost complete removal of the thyreoid gland.

2. (*a*) *Nodular Toxic Goître Following Exophthalmic Goître.*

In nodular toxic goître following exophthalmic goître the gland contains multiple nodules varying in size and number in different cases. These nodules are not true tumours, but consist of masses of thyreoid tissue containing, as a rule, excessive colloid, together with, in many places, areas of hyperplasia. There is commonly some general enlargement of the gland substance apart from the nodules, and microscopic examination of the perinodular tissue reveals evidence of hyperplasia. Portions of the gland usually show changes indistinguishable from those found, more diffusely, in exophthalmic goître. Plummer[3] believed that these cases differed from the true exophthalmic type in that a different thyreoid secretion was produced and that they did not react in the same way to iodine administration. It has been shown quite clearly that this view is incorrect and that cases of nodular toxic goître react in precisely the same way, and sometimes to the same extent, as do cases of exophthalmic goître.

In this group of cases the nervous symptoms and the general disturbance of metabolism are present, but are less intense than in the exophthalmic group. The cardiac signs, on the other hand, are more pronounced and auricular fibrillation is common. It is important to note that the basal metabolic rate is not a reliable guide in this condition, as, in some cases in which it was normal or subnormal, relief of symptoms has followed thyreoidectomy. This group comprises those patients who have received medical treatment for exophthalmic goître, and who have derived such benefit therefrom that it is supposed that a cure has been achieved. A state of mild chronic intoxication persists, however, and may produce permanent damage in the heart and other tissues. It is open to question whether the thyreoid intoxication itself produces myocardial damage; it seems more probable that this is due to the fact that the heart is overdriven, becomes exhausted more readily, and is thus less able to resist the natural ageing processes. These patients often do not seek advice until after the onset of auricular fibrillation or of the heart failure resulting from it. Though, as has been stated, these patients give the history that they had suffered from frank exophthalmic goître some years earlier and had been classed as cured after medical treatment, a careful review of the story will demonstrate that a mild or moderate degree of hyperthyreoidism was

present during the intervening period, despite the fact that there was never enough discomfort to cause the patient to seek medical advice. This supports Rienhoff's[4] belief that the thyreoid nodules are, in the vast majority of cases, areas of hyperinvolution left after the remission of an attack, possibly quite mild, of overactivity or of local hyperplasia and that, in such cases, there is a chronic mild state of thyreoid intoxication.

Because, in this clinical group, the cardiac symptoms are especially notable, the view is commonly held that the toxæmia is mild and shows its effect only in tissues which are damaged to some extent by the changes of advancing years. It is doubtful whether this assumption is correct because, though the usual age incidence of striking symptoms is in or after the fourth decade, there are exceptions in which a nodular toxic goître with severe symptoms is found in comparatively young people.

Finally, it must be emphasized that, though the symptoms of a typical case of exophthalmic goître are easily distinguishable from those of a mild nodular toxic goître, these two conditions are manifestations of one disease in which many different combinations of symptoms occur, with the result that one observer will classify a particular case as exophthalmic goître, while others would describe it as "secondary Graves disease", "toxic adenomatosis" or "nodular toxic goître". It seems more satisfactory to regard all these conditions as one disease in which different cases exhibit a different incidence of the intoxication upon the function of various organs. This being the case, it naturally follows that the surgical treatment of nodular toxic goître is precisely similar to that adopted in exophthalmic goître, namely, a subtotal thyreoidectomy.

In other cases, attention is directed to the condition by the fact that convalescence after some infection is delayed, and that strength and cardio-vascular efficiency fail to be restored until the thyreoid condition has received appropriate treatment.

2. (*b*) *Nodular Toxic Goître Without Antecedent Acute Symptoms.*

The clinical group of nodular toxic goître without antecedent acute symptoms comprises those patients in whom a nodular enlargement of the thyreoid, often following a colloid goître, has been present for years. Usually the thyreoid swelling is obvious, but occasionally the nodules are detectable only on palpation, the patient being unaware of their presence. There is no history of antecedent acute thyreoid intoxication and the onset of toxic symptoms is commonly in or after the fifth decade.

Though a condition precisely similar to exophthalmic goître may occur in a patient in whom a colloid or endemic goître has been present for a long time, the toxic symptoms characteristic of this group are mainly cardiac in nature and the nervous and general metabolic disturbances are not marked. The patient usually seeks advice for auricular

fibrillation or its sequelæ and, very often, the cardiac condition is regarded as primary, the goître being overlooked by both doctor and patient owing to the fact that it has been present for so long without causing toxic symptoms. Such an oversight is particularly unfortunate, because, unless the thyreoid is treated surgically, the results of treatment of the cardiac condition are very disappointing.

The general remarks contained in section 2 (*a*) apply equally well to this clinical group and similar surgical treatment is necessary.

3. *The Toxic Single Lump.*

The inelegant title, "toxic single lump", is used to denote those cases in which there is a single mass in an otherwise normal thyreoid, and in which toxic signs are present. The single lump is found in about 8% of goître cases, and, usually, does not cause symptoms for many years; that is, until the end of the fourth or fifth decade.

The term "lump" is used because it is uncertain whether the mass is a true adenoma. In some cases the histological structure is that of ordinary thyreoid tissue and not of a new growth, while in others, indistinguishable clinically, the mass is encapsuled and is probably a true adenoma. Though it is a debatable point, it is probable that a true adenoma can produce toxic symptoms late in life, either from overactivity of its own cells or of the cells of the gland tissue in its immediate vicinity. The toxic symptoms are cardiac in type and usually consist of paroxysmal or persistent auricular fibrillation with variable degrees of distress. In addition to these symptoms, the lump produces pressure signs, and the rise of venous pressure resulting from a paroxysm of fibrillation may distend it considerably, giving rise to partial asphyxia with accompanying great distress to the patient. In cases in which a single lump is producing toxic symptoms, the removal of the lump, together with the thyreoid tissue immediately surrounding it, results in complete cure. Before performing this operation, the surgeon must satisfy himself that the remainder of the gland is normal; in other words, that he is not confronted by a case of nodular goître in which the size of one nodule overshadows that of the remainder.

It is difficult to decide how this type of case should be treated in young women who have no toxic symptoms, but present themselves for examination because attention has been directed to the presence of the lump. No figures concerning the incidence, later in life, of toxic symptoms in such cases are available, but it seems probable that this is high. In view of this supposition, it seems better to advise surgical removal of the lump before the incidence of toxic signs, for these, at their inception, are slight and easily overlooked and quite severe cardiac damage may have resulted before the condition is detected. Operative treatment should be confined to the removal of the lump, together with the adjacent portion of the thyreoid gland, as it is obviously unreasonable to perform a subtotal thyreoidectomy in a young woman whose metabolism is normal and who is otherwise in perfect health.

Cardiac Arrhythmia in Toxic Goître.

There has been recently much discussion about the importance of the arrhythmia of auricular fibrillation, which is, of course, common in patients other than those affected by thyreoid toxæmia. It occurs in paroxysms in hearts which, when a regular rhythm is restored, are apparently quite normal. Such patients can often follow a laborious life for many years without difficulty, so that it follows that this arrhythmia is not necessarily of grave pathological significance and that, in these patients, an organic lesion, if present at all, must be comparatively unimportant.

Auricular fibrillation is especially common in cases of toxic goître, more particularly when the toxæmia has acted over a prolonged period, as is the case in the nodular group. In exophthalmic goître a transient paroxysm is quite common after operation, being due, presumably, to the sudden liberation of an overwhelming dose of toxin, but apart from such attacks, auricular fibrillation usually occurs in this group only after many months of poisoning, when it is of significance because it causes the rapid onset of heart failure.

Post-operative auricular fibrillation is of little moment, as it usually lasts only for a short time and disappears spontaneously. Though the ventricular rate is rapid owing to the thyreoid toxæmia, it is usually undesirable to increase the patient's discomfort by the administration of digitalis. When either fibrillation, flutter or tachycardia is associated with a severe post-operative crisis, attention should rather be directed to the treatment of the crisis, because, when this has subsided, the normal rhythm will be restored.

The presence of an established auricular fibrillation without congestive heart failure is also of slight importance to the surgeon, as this arrhythmia does not complicate the administration of an anæsthetic nor prejudice the success of operative treatment. If the rapid irregular heart action is causing distress to the patient, digitalis will give relief and, if the patient has not already been treated by iodine, the ventricular rate will fall as the remission produced by this drug becomes evident. When congestive heart failure is present, it must be controlled by appropriate medical treatment before the patient is submitted to operation. The surgeon who boasts that he has successfully performed thyreoidectomy in a water-logged patient, is merely betraying his ignorance, for there is no necessity for action so foolhardy as an operation upon a patient in this condition.

Whereas auricular fibrillation in the normal or only mildly poisoned heart merely produces an unpleasant feeling of palpitation, failure being very gradual, its effect is more important in cases of nodular toxic goître in which the toxæmia has been present for a long time, because a severe failure may follow rapidly with accompanying cyanosis, dyspnœa and œdema. Reference has already been made to the fact that such cases may be regarded as primarily cardiac in nature and that the presence of a small goître, or even a large goître if it be mainly retrosternal,

may be unnoticed. Examination of the thyreoid gland is of the greatest importance in all patients suffering from auricular fibrillation. Despite the rapid onset of heart failure in many of these cases, it by no means necessarily follows that myocardial degeneration is present, for, after operation, it is not unusual to find that a patient, who has been an invalid for some time owing to cardiac inefficiency, is restored to a state of health comparable to that of a normal person of the same age. The heart failure in such cases is due simply to the thyreoid poisoning and is not to be explained by, or considered as an index of, degeneration in the heart muscle due to the advanced age of the patient. The following case is of interest in this connexion:

CASE I.—A female patient, aged sixty-three years, was first seen nine years ago, thirty-six hours after the onset of heart failure with auricular fibrillation. She stated that she had noticed the presence of a goître for many years. She was very distressed by the symptoms of heart failure, particularly by the dyspnœa, which was probably increased by the fact that her nodular goître extended into the thorax behind the left clavicle. The ventricular rate was 140. After the heart failure had been controlled by digitalis, the greater part of the thyreoid gland was removed. She convalesced satisfactorily, but her heart failed to return to a normal rhythm. She refused to take quinidine and was discharged from hospital with a resting ventricular rate of 80. Despite the fact that auricular fibrillation persisted, she continued in active work as a hospital administrator for seven years without any sign of heart failure. She did not take any medicine except a very occasional dose of digitalis. She then successfully underwent a severe operation for removal of a carcinoma of the sigmoid colon, after which she resumed her onerous duties for another year. She developed a recurrence of the growth from which she died a year later at the age of seventy-two years.

Though this case illustrates the fact that heart failure may be due solely to the thyreoid toxæmia, there are, as has been stated, other cases in which myocardial damage is present owing to the fact that the heart has been overdriven and has become so exhausted that it has been less able to resist the natural ageing processes. It is, therefore, desirable to attempt to determine the state of the heart muscle before operation, in order to estimate the degree of recovery which will follow this procedure. Unhappily, it is difficult, if not impossible, to arrive at an accurate decision on this point. Electrocardiograms are not likely to help, not only because normal curves may be obtained from hearts which are gravely damaged, but also because the curves register changes of function and not of structure, so that alterations in them may be due to the thyreoid poisoning and may disappear when this is removed. Estimations of the ventricular rate or of the degree of heart failure do not help, as a good post-operative result may be obtained in cases in which the rate is very rapid or the failure is extreme. Probably the best guide is the response made by the patient to rest and to treatment with iodine and digitalis, for, if this is satisfactory in degree, the outlook is encouraging. A sign of grave significance is the persistence of marked dyspnœa on exertion in cases in which there is no evidence of tracheal pressure from the goître. This last proviso is important, for tracheal pressure in a nodular goître may greatly increase the difficulty in

breathing, thus giving a false impression as to the extent of the heart damage. In some such cases the pressure produces attacks which are asthmatical in type. When all is said and done, recourse must be had to operation, as, even in cases in which the response to treatment is poor, this step, by removing the element of thyreoid intoxication, offers the patient the only prospect of improvement. Neither auricular fibrillation nor heart failure is a contraindication to operation; indeed, these are simply indications that futile treatment has been adopted for too long a time, and that early operation is imperative.

It will have been noted, in Case I, that a satisfactory result followed thyreoidectomy, despite the fact that a normal cardiac rhythm was not resumed. In cases of paroxysmal fibrillation the attacks almost invariably cease after an adequate thyreoidectomy, but when the arrhythmia is persistent restoration of the normal rhythm after operation is less certain and depends largely upon the duration of the fibrillation. If this be recent in origin, a normal rhythm is restored in practically every case, but in cases of long duration post-operative restoration is less certain. In this series there were 36 cases of persistent fibrillation, and restoration of a normal rhythm followed operation in 26 (75%). It was unfortunately impossible in many of these cases to determine the duration of the arrhythmia.

Those patients in whom the auricular fibrillation persists after operation with a ventricular rate of 80 or less, are usually able to resume their normal activities without any symptoms, even though no digitalis is administered. In other cases of this type, the ventricular rate can be controlled by moderate doses of digitalis, whereas, before operation, control was impossible unless the patient was completely at rest. In such cases it seems that there is little to be gained by the use of quinidine. This drug is, however, of value in cases in which the ventricular rate is more rapid, as it brings about a restoration of the normal rhythm in approximately 50% of cases. It is proper to allow two weeks to elapse after operation before administering quinidine.

Pre-operative treatment with quinidine in cases of thyreotoxicosis is undesirable, because, though a normal rhythm may be restored, the arrhythmia will almost certainly recur, and this treatment is very unpleasant to a patient whose heart is being overdriven by this disease. Satisfactory results have been recorded by Dunhill, Fraser and Stott[5] and also by Parkinson[6] in cases in which all thyreotoxicosis seemed to have ceased, but do not appear to have been obtained in active cases. As the operation is not rendered more difficult or more dangerous by the presence of auricular fibrillation, and as there is no reliable method of determining whether the goître is really quiescent, it seems desirable to operate upon all such patients and to confine the use of quinidine to those in whom, after thyreoidectomy, arrhythmia persists with a rapid ventricular rate.

Restoration of a normal rhythm is not always permanent, for cases occur in which fibrillation recurs after a period of years after operation, though, in such cases, the ventricular rate is slow and the patient is not

inconvenienced by the arrhythmia. In other cases, paroxysmal fibrillation may persist even when only a small amount of thyreoid tissue is left after operation. Probably in such cases complete thyreoidectomy would be effective, but, as there are many people in whom fibrillation occurs without thyreoid disease, such a procedure seems hardly justified.

PRE-OPERATIVE TREATMENT.

Pre-operative treatment will be considered under the following headings: (*a*) The misuse of iodine, (*b*) the use of iodine, (*c*) the treatment of focal infections, (*d*) general principles.

The Misuse of Iodine.

The experience gained from this series of cases confirms the belief that it has become a very common practice to treat patients suffering from toxic goître with iodine for long periods in the hope of effecting a cure. The majority of these patients are eventually advised to undergo surgical treatment which is rendered much more difficult by the previous iodine therapy. It has been conclusively demonstrated by many observers that iodine, though it commonly produces a complete remission when first administered, will not maintain this state indefinitely, and that a toxic condition, often more severe than that originally present, recurs. This happens whether the iodine has been continued or not, and places the surgeon in a most awkward position. It is true that a further remission can sometimes be produced by increasing the dose of iodine, particularly if this has been small in the first instance, but many cases prove quite refractory. In such circumstances the surgeon is compelled to adopt one of two alternatives. He may elect to operate with the knowledge that the risk of a post-operative crisis is considerably increased and that, if it occurs, his most valuable therapeutic weapon is useless. He may, on the other hand, stop the administration of iodine, keep the patient at rest in bed and take such precautions as he can to diminish the effects of the exacerbation which will probably follow this step. This exacerbation will be succeeded by a natural remission and, usually in about four months, the patient will cease to be refractory to iodine, so that the usual routine pre-operative treatment can be given with success. The adoption of this alternative necessarily means that months are wasted during which the patient's tissues are exposed to the effects of the thyreoid intoxication from which permanent damage may result.

In the present state of our knowledge, it seems reasonable to insist that iodine should not be used in the medical treatment of thyreotoxicosis, but should be confined to pre-operative preparation.

The Use of Iodine.

An enormous amount of careful work has been done in investigating the effect of the administration of iodine in thyreotoxicosis, but, though there is fairly general agreement on the way it should be used, its mode

of action is unknown. It is of the greatest value in the pre-operative preparation of patients with thyreotoxicosis and is also useful to unmask toxicity in cases in which the presence of this condition is suspected. The administration of iodine is followed by a reduction of the basal metabolic rate by approximately 50% in about three-fourths of all definitely toxic cases, both exophthalmic and nodular types responding in the same manner to the drug, though the response is greater in actively hyperplastic glands. Though a good remission may follow the administration of very small doses, even as little as 0·06 mil (one minim) of Lugol's solution a day, it appears, from most reports, that even in these cases the effect is increased by larger doses, so that not less than 1·0 mil (fifteen minims) a day should be given in order to obtain full effects in a maximum number of cases. Thompson[7] has shown that the best results are obtained by giving full doses from the beginning. It has been the usual practice in this series of cases to administer Lugol's solution in doses of from 2·0 to 3·0 mils (thirty to forty-five minims) daily, for it has appeared that definite progress has been made when smaller doses have been increased to this amount. In a patient who has not previously been given iodine and who is sensitive to this drug, the remission begins immediately and is usually at its maximum in from ten to sixteen days, so that the optimum time for operation is, as a rule, at the end of the second or in the third week after the first dose. The drug acts more effectively if the patient is kept at rest in bed during its administration, but, if this is inconvenient for economic or other reasons, treatment may be begun a week before the patient's admission to hospital.

Iodine may also be used to unmask toxicity in suspected cases, for the symptoms of mild hyperthyreoidism will at first disappear under its influence, only to recur in greater degree after the continued administration of the drug or after stopping its administration. This appears to be a safe procedure in cases of this nature, provided that administration of iodine is continued both before and during the operative period.

The Treatment of Focal Infections.

Though many writers on this question insist that focal infections should be sought for and removed before thyreoidectomy is performed, the basis for this advice seems to be unsound. The evidence brought forward to show that hyperthyreoidism is due to the effect of poisoning from infection in some other organ is unconvincing, and there is a conspicuous absence, in the literature, of reports of cases in which, though the condition was sufficiently severe to make operation reasonably probable, patients have been saved this necessity by the removal of focal sepsis. A preliminary operation for removal of the tonsils, for example, is a very severe trial for a patient suffering from hyperthyreoidism, and, further, if the risks of this procedure are reduced by the administration of iodine, the remission will be over before the patient is ready for thyreoidectomy, the risk of this operation being thus greatly

increased. Plummer and Charles Mayo, Second,[8] state that though, in their experience, patients with exophthalmic goître are prone to have tonsils from which fluid pus can be expressed, it is their impression that the tendency to attacks of acute tonsillitis, which seems to exist in cases of this nature, usually has developed after, rather than before, the onset of the exophthalmic goître. In all cases of toxic goître the first operation performed should be thyreoidectomy. If focal sepsis be present and if it continues to give symptoms, it can be treated more safely and more easily after recovery from the thyreotoxic symptoms. It is interesting to note that Joll,[9] in a review of 795 cases of toxic goître, expresses a similar opinion. Advice to the contrary seems to be somewhat thoughtless, for, if it were sound, surely a convincing series of cases, in which real benefit had resulted, would be forthcoming.

General Principles.

All patients should be admitted to hospital at least a week prior to operation, in order that they may be accustomed to their surroundings. The period of pre-operative rest naturally varies with each individual case, and, as has been stated, also depends upon whether there has been a prolonged pre-operative administration of iodine. Moderate doses of bromide are usually given, together with soporifics, such as barbitone, to induce sleep. A daily dose of 4·0 grammes (sixty grains) of calcium lactate is given before breakfast for a week before operation. Though no special diet is necessary as a rule, food should be ample in quantity and should contain large quantities of carbohydrate, and there should be some restriction in the amount of meat. In cases in which glycosuria, with a high blood sugar content, is present, this should be controlled by diet and insulin as far as possible before operation, though care is necessary to avoid overdosage with insulin after operation. If congestive heart failure is present, it must be controlled by digitalis, and the patient should be allowed a short period of comfort before the operation is performed. In cases of auricular fibrillation without heart failure, digitalis is not given unless the patient complains of the sensation produced by the rapid irregular action of the heart. In such cases, which are usually associated with severe thyreotoxicosis, digitalis lessens the distress by controlling the ventricular rate. Quinidine is never given before operation. Repeated observations of the basal metabolic rate are valuable in estimating the effect of treatment, but may be replaced in almost every case by careful clinical observation. In private cases, no information about the time of operation is given to the patient nor is any skin preparation done until after the subcutaneous injection of morphine 0·015 gramme (one-sixth of a grain) one hour before it is due to take place. In public hospital cases it has not been found possible always to withhold this information, but it is very undesirable to increase the patient's distress by a transfer to the surgical ward before operation. These patients should be prepared in the medical ward and should go from it straight to the operating theatre. If a

patient is found to be unduly worried or excited on the day fixed for operation, this should be postponed, as these symptoms indicate an inadequate pre-operative preparation.

THE OPERATIVE TREATMENT OF TOXIC GOÎTRE.

The modern operation for toxic goître is a bilateral resection of the thyreoid gland, leaving only a small portion covering the recurrent nerve on each side. The gradual evolution of this operation in the last three decades is due to the work of many distinguished surgeons in different countries, but it is not yet universally recognized that Dunhill[10] was the first to stress the importance of an extensive bilateral resection of the gland in this disease. Recently Keith Fairley,[11] in a valuable review of 353 cases treated at the Melbourne Hospital, has shown that any operation less extensive than a bilateral resection failed to give satisfactory results. There is still some difference of opinion concerning the advisability of performing this resection in one stage. In the earlier cases in this series a two-stage removal of the gland was the routine procedure, but, as a "follow-up" investigation of these patients revealed certain disadvantages of the method and, perhaps, as surgical confidence increased with experience, it was replaced by a bilateral one-stage removal. This operation was performed in 161 of the last 163 cases, staging being employed only in two cases in which the technical difficulties were materially increased by the presence of a very large friable gland with severe thyreotoxicosis. Removal of the second lobe usually adds very little to the operating time, and has not been accompanied in this series by an increase in the post-operative reaction or in the rate of mortality. In point of fact, the latter has decreased since the adoption of this method, though the decrease may be due to other factors, such as increased operative experience.

Reference has been made to the disadvantages accompanying a two-stage resection of the gland. It is sometimes difficult to be sure that this is adequate, as some thyreoid tissue may be included in the scar left after the first operation in front of the trachea and so escape removal at the second stage. In four cases in this series thyreoid tissue left in this situation subsequently enlarged, caused a recurrence of the toxæmia and necessitated the performance of a third operation. Another objection is that the patient may refuse to undergo a second operation and may escape from observation. It frequently happens, in such cases, that the surgeon is not again consulted until the prolonged effect of continued thyreoid intoxication has so injured the heart and other viscera that the risks of thyreoidectomy are enormously increased. It is interesting to note that the two deaths which occurred among the private patients in this series were in this type of case. Finally, it is obviously desirable, from the point of view of the patient, to perform the operation, if possible, in one stage. Though no good surgeon is wedded to a routine procedure, but suits the operative technique to the patient, there seems no doubt that, in the great majority of cases, a

bilateral one-stage resection is the operation of choice. If, for some special reason, such as technical difficulty in the presence of a large gland or severe thyreotoxicosis, the resection is performed in two stages, the second stage should be done before the patient is allowed to leave the hospital, preferably not later than seven to ten days after the first stage.

Before discussing the operative technique, brief reference must be made to the question of anæsthesia in these cases. In this series, nitrous oxide and oxygen has been employed as a routine, without the preliminary injection of a local anæsthetic. Patients who have had a resection of one lobe performed in another clinic under local anæsthesia and have subsequently undergone a second stage operation under nitrous oxide and oxygen, state that the latter method is infinitely more comfortable from their point of view. It must be administered by one skilled in its use, for, if badly given, it can be very dangerous owing to the effect of the cyanosis produced under these circumstances. The anæsthesia is so light that the patient can be induced to cough or to speak at any time, thus permitting a phonation test at any stage during the operation. Though local anæsthesia has been employed in some cases, the best results have been obtained from nitrous oxide and oxygen skilfully administered. Ether anæsthesia induced by the open method

TABLE I.

Anæsthetic.	Number of Operations.	Pulmonary Complications.	Percentage.
Nitrous oxide and oxygen	363	5	1·3
Ether given by the open method	72	5	6·9
Ether given intratracheally	79	15	18·9

was employed in some of the earlier cases, but has the disadvantage that post-operative respiratory complications are more common after its use. For this reason, also, intratracheally administered ether is a most undesirable anæsthetic in cases of toxic goître. The incidence of post-operative pulmonary complications after anæsthesia in operations for toxic goître at the Melbourne Hospital has been investigated by G. L. Lillies,[12] and his findings are summarized in Table I.

The following description of the operative technique is given with apologies, for it differs only in minor details from many already reported, all of which are based upon the same fundamental principles.

The skin incision is mainly transverse in direction with a slight upward curve at each end, is situated low in the neck, so that it can later be concealed by a string of beads, and should be made with a sharp knife in order to avoid a ragged edge (see Figure I). The skin, superficial fat and the platysma muscle are divided, but care must be taken to avoid injury to the anterior jugular veins which lie deep to this muscle.

After applying curved hæmostatic forceps (this type is used throughout the operation) to all bleeding points in the skin wound, the upper flap is reflected as high as the thyreoid cartilage and the lower flap to the upper border of the manubrium. This reflection, if made in the correct plane between the deep surface of the platysma and the cervical fascia, can be easily and rapidly accomplished by the gauze-covered finger of the surgeon. Bleeding points on the superficial surface of the depressor muscles are then clamped and ligated with catgut in order to get the forceps out of the way before the gland is approached. Though silk is used for tying the vessels of the gland, it should be avoided in the superficial parts of the wound in order to decrease the risk of stitch abscesses at a later stage. After reflection of the flaps, the skin edges are covered with gauze packs and a self-retaining retractor is placed in position (see Figure II).

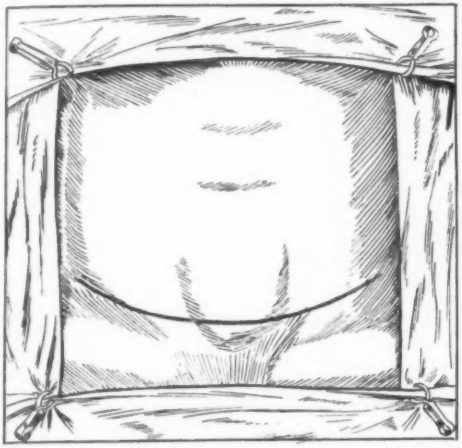

FIGURE I. Showing the line of the skin incision.

A Y-shaped incision is then made in the sterno-hyoid muscles (see Figure II). The diverging limbs of this incision divide only the inner halves of the muscles near the thyreoid cartilage and greatly facilitate the approach to the upper poles of the gland, though they are unnecessary if the goître is small. This incision exposes the thin sterno-thyreoid muscles overlying the gland. This

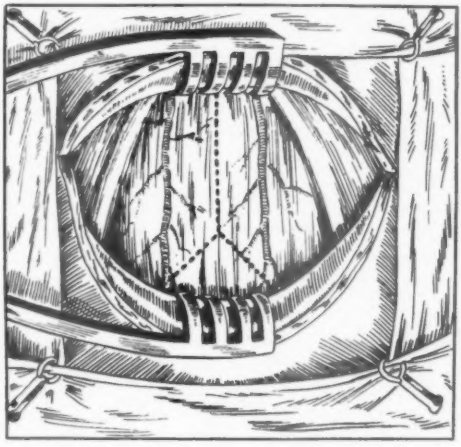

FIGURE II. The skin flaps have been reflected and a self-retaining retractor has been inserted. The site of the Y-shaped incision on the sterno-hyoid muscle is indicated by the dotted line.

muscle, together with the subjacent gland capsule, is then separated, on the side first to be resected, from the gland surface by dissection with a blunt-pointed curved scissors (see Figure III) and is then divided in an upward and outward direction between forceps. The vessels in the divided muscle surfaces are then transfixed and ligated with catgut.

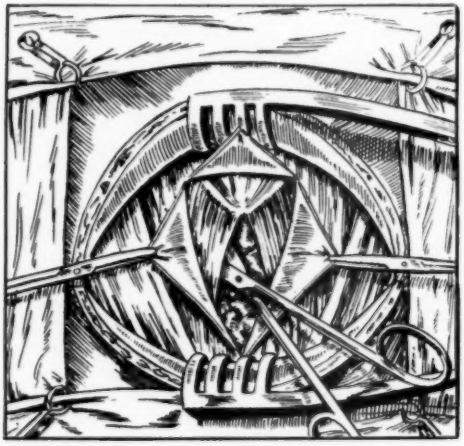

FIGURE III. The Y-shaped incision in the sterno-hyoid muscles has been made. The right sterno-thyreoid muscle is being separated from the subjacent upper pole of the gland.

The lateral edge of the upper pole of the gland is now gently separated from the capsule by introducing the scissors through the upper end of the incision in the sterno-thyreoid muscle (see Figure IV). This makes a space through which the finger can be passed behind the upper pole (see Figure V). Gentle traction will then expose the superior thyreoid vessels for an appreciable distance above the upper pole. These vessels are then divided between two proximal and one distal forceps (see Figure VI).

Attention is then directed to the inner side of the upper extension of the gland. Here a tough band of tissue containing some vessels, known as the suspensory ligament of the thyreoid, passes upwards towards the superficial surface of the larynx. This is divided between forceps (see Figure VII), a step which not only exposes the

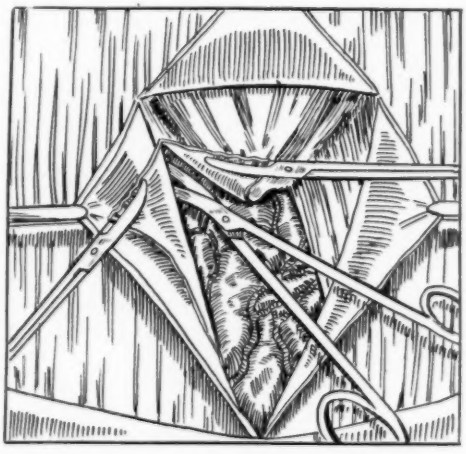

FIGURE IV. The inner fibres of the upper end of the sterno-thyreoid muscle have been divided. The lateral border of the upper pole is being separated from its capsule with blunt pointed scissors.

trachea above the isthmus, but also permits of access to a fascial space between the larynx and the upper part of the gland. It is common to find in the depths of this space an extension of the upper pole passing inwards behind the pharynx. This must be delivered with care, for, if the superior thyreoid artery has not been divided well above the upper pole, it will be necessary to apply forceps to some of its branches entering the upper border of this retro-pharyngeal extension (see Figure VIII).

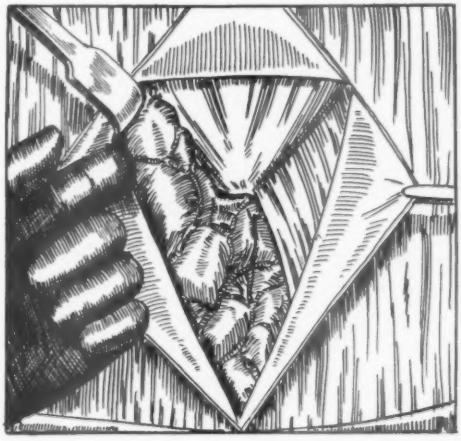

FIGURE V. The surgeon's finger is passed behind the upper pole through the space made after dissection with the scissors.

The upper pole being thus freed from its attachments, the surgeon gently draws the lower pole into view, and divides the inferior veins progressively between forceps until this pole also is freed and the trachea below the isthmus is exposed (see Figure IX). The forceps attached to the two poles are then used for traction purposes in order to draw the lobe towards the opposite side, thus exposing its postero-lateral aspect. This exposure must be adequate, and is best accomplished by g a u z e dissection. The m i d d l e thyreoid veins are divided at this stage.

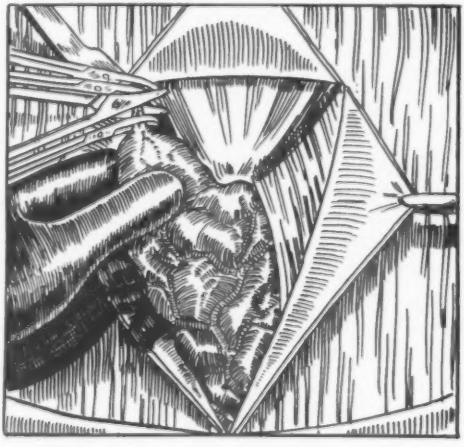

FIGURE VI. The superior thyreoid vessels are being divided between forceps.

It is now necessary to determine the plane of the incision through the posterior aspect of the lobe, or, in other words, the amount of thyreoid tissue to be left *in situ*. It is i m p o s s i b l e to standardize this procedure if the exposure is inadequate. Having made this

decision, the surgeon then proceeds to divide the gland along the appropriate plane after achieving hæmostasis by the introduction of forceps into its substance (see Figure X). The inferior thyreoid vessels are caught as the division proceeds. If the trachea above and below the isthmus has been properly exposed, it is not difficult to complete the division in such a manner that the avascular space between the isthmus and the trachea is opened. The isthmus is then peeled off the surface of the trachea, clamped at its junction with the opposite lobe and divided (see Figure XI).

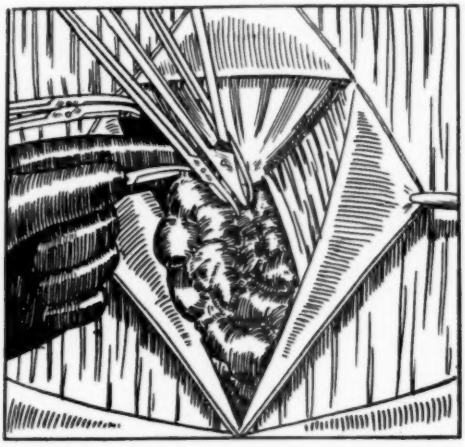

FIGURE VII. The vessels on the inner aspect of the upper pole are being divided between forceps.

The vessels, with the exception of the superior and inferior thyreoid arteries for which thread is employed, are then ligated with number 0 silk prepared by boiling in a solution of perchloride of mercury.

At this stage, the surgeon must consult with the anæsthetist concerning the advisability of resecting the other lobe, a decision which is influenced by the time already taken and the condition of the patient. This resection of the lobe is performed in an identical manner to that already described. It is usually convenient to resect the right lobe first and to include a removal of the pyramidal lobe, when present, with the resection of the left lobe, to which it is attached in the majority of cases.

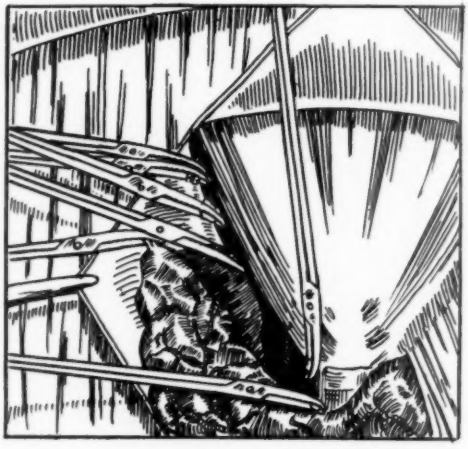

FIGURE VIII. Delivery of the retro-pharyngeal extension of the upper pole.

After ligation of the vessels divided during the removal of the left lobe, mattress sutures of silk are introduced in the small portions of gland left on each side (see Figure XII), a step of importance in the prevention of reactionary hæmorrhage. The wound is carefully inspected to make sure that no bleeding point has been overlooked, and the depressor muscles are then brought together with catgut sutures (see Figure XIII). A small tube drain is brought out through a buttonhole incision in the muscle and emerges through the skin incision near its lateral end. This prevents the ugly elevation of the centre of the incision on swallowing which results from the practice of bringing the tube out in the middle line. The practice of making a separate buttonhole below the skin incision for the tube is to be condemned, as the resulting scar is often much more unsightly than the incision itself. The skin is brought together with Michel clips (see Figure XIV) and a bandage applied over sterile gauze dressings.

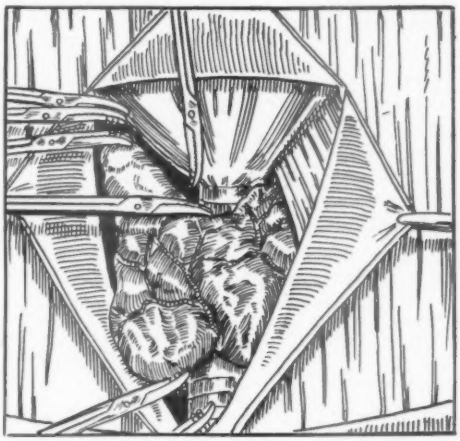

FIGURE IX. The inferior thyreoid veins have been divided between forceps. The trachea is exposed below the isthmus.

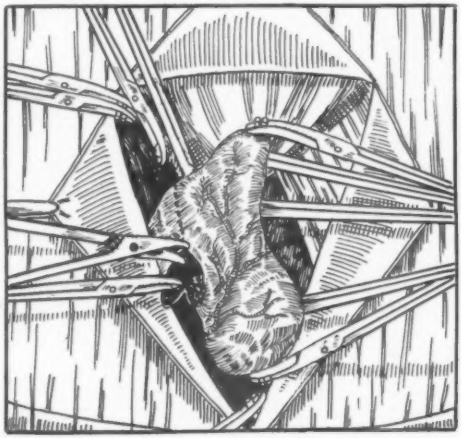

FIGURE X. The postero-lateral aspect of the lobe has been exposed and the lobe is drawn towards the opposite side. Resection is being completed with scissors, after clamping the vessels with forceps introduced into the gland substance posterior to the plane of division. The inferior thyreoid vessels are caught as this division proceeds.

Throughout the operation, efficient hæmostasis and gentleness in manipulation are much more important than speed. Loss of blood gravely prejudices the post-operative prognosis,

and must be avoided at all costs. It should not be necessary to wipe the back of the neck before applying a bandage at the end of the operation. Rough traction on the lobes must be avoided, as this is a common cause of injury to the recurrent nerves. Though speed is not of first importance, it is desirable to finish the operation in from forty to fifty minutes, and it should not in any case take more than one hour to complete a bilateral resection. In some cases it can be completed in thirty minutes.

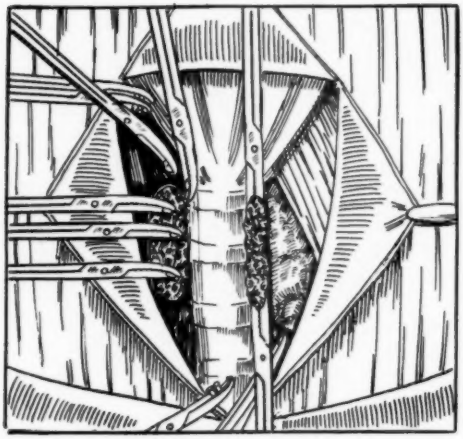

FIGURE XI. Resection of the right lobe and isthmus has been completed. The trachea is exposed and the isthmus has been divided at its junction with the left lobe.

As Rienhoff[13] points out, though in 5% of cases speed is still necessary and justifiable, in the remaining 95% of patients, operated upon in accordance with modern methods, a more deliberate and methodical operation can be performed not only with the expectation of a low mortality rate, but also of a high percentage of cures and a minimal percentage of recurrences. The smaller the amount of thyreoid tissue left, up to within a certain minimum, the more easily is the bleeding controlled and the more effective the surgical therapy. The proper amount to be left is a matter for the surgeon's judgement. No surgeon can develop this judgement unless he performs a systematic operation leaving a definite known amount of thyreoid tissue, and then examines the patient at intervals over a period of years in

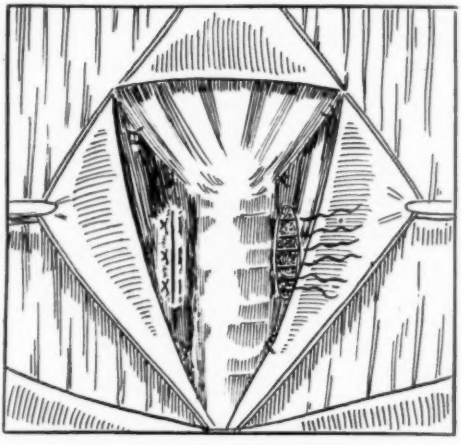

FIGURE XII. The resection of the left lobe has been completed. Hæmostatic mattress sutures have been introduced in the portions of the gland left *in situ*.

order to determine whether the removal has been adequate. Statistics on surgical results are worthless unless the amount left has been standardized by the surgeon concerned.

The technique already described must be varied in those cases in which a large intrathoracic extension of the gland is present. In these it is essential to liberate the cervical portion of the affected lobe before any attempt is made to deliver the mediastinal portion. The arteries supplying the latter come from above, so that, if they are first divided between forceps, the intrathoracic extension can be delivered without much risk of hæmorrhage. In such cases, the superior pedicle is divided in the usual way (see Figure XV), after which the middle thyreoid veins are clamped and divided. The inferior thyreoid vessels are then divided in the substance of the lobe in the course of an incision through its posterior aspect, which leaves the usual small amount of gland over the recurrent nerve (see Figure XVI). This incision is continued half-way across the posterior portion of the lobe and is completed from the inner side after division of the isthmus (see Figure XVII). In this manner, the cervical portion of the lobe is completely detached from its blood supply. Gentle traction of this part of the gland will then bring the mediastinal extension

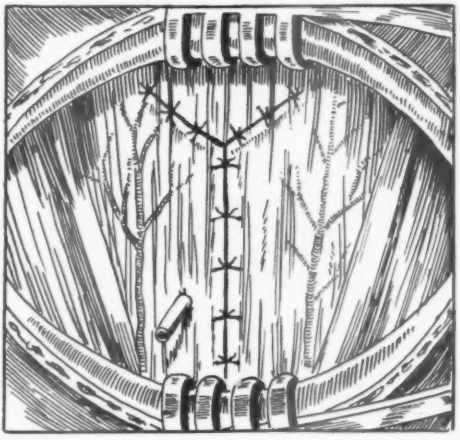

FIGURE XIII. Suture of the Y-shaped incision in the depressor muscles. The drainage tube is brought out through a buttonhole incision in the muscles.

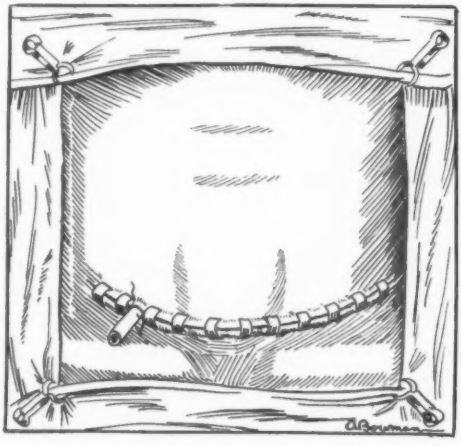

FIGURE XIV. Showing the skin incision brought together with Michel's clips and the lateral position of the drainage tube.

gradually into view (see Figure XVIII). The inferior thyreoid veins usually enter the upper part of this extension and are clamped and divided as they appear. Attempts to deliver the mediastinal extension before the cervical portion of the lobe has been resected are highly dangerous, as very troublesome, if not fatal, hæmorrhage may result.

The following cases illustrate intrathoracic extensions of toxic goîtres which were operated upon in this manner.

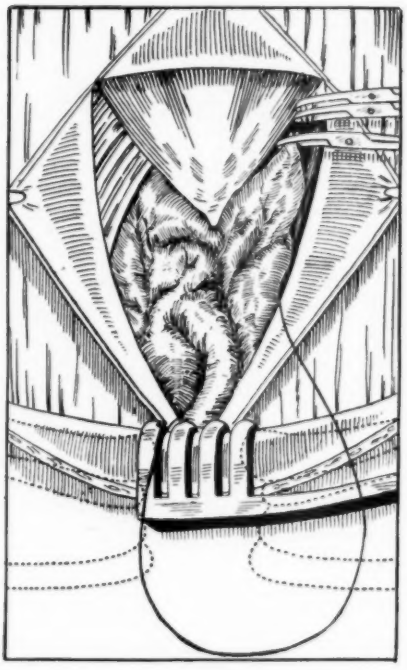

FIGURE XV. Removal of an intrathoracic goître. The superior thyreoid vessels are divided in the usual manner.

CASE II.—A female patient, aged thirty-eight years, was seen on July 19, 1928. A large goître had been present for many years. For the last twelve months she had suffered from increasing nervousness and attacks of palpitation in which she noticed that her heart was beating irregularly. On examination, it was found that there was a moderate degree of nodular enlargement of the right lobe and that, though the left lobe was not enlarged in the neck, it was apparently continuous with an intrathoracic extension. The presence of an intrathoracic goître was confirmed by X ray examination (see Figure XIX). The basal metabolic rate was +25%. At the first examination the patient was seen in an attack of paroxysmal fibrillation, but this had subsided when she was admitted to hospital. At the operation on August 13, 1928, the greater part of the right lobe was resected in the ordinary way, after which the left lobe, together with the intrathoracic extension, was removed by the method described above. The growth extended into the mediastinum for 8·75 centimetres (three and a half inches) (see Figure XX). The patient made a good recovery from the operation, but has since developed signs of subthyreoidism.

CASE III.—A male patient, aged fifty-six years, was first seen on March 8, 1932, in consultation with Sir Richard Stawell. In 1915 the patient had suffered from thyreotoxicosis without exophthalmos, and a right hemithyreoidectomy was performed in another State at that time. Nine years later he was examined as a matter of routine and no sign of hyperthyreoidism was detected. For the last year he had been losing weight, had become increasingly nervous and unfit to perform his work. There was some tremor of the hands. His pulse rate varied from 72 to 84. The basic metabolic rate was +16%. A small round swelling could be felt just above the suprasternal notch, but there was no enlargement of the left lobe in the neck. X ray examination showed that the suprasternal swelling was continuous with a large intrathoracic goître which extended downwards to the lower border of the arch of the aorta (see Figure

XXI). It is interesting to note that it was posterior to the trachea. This was removed on March 18, 1932, leaving only a small portion of the left lobe *in situ*. The growth extended downwards into the mediastinum for 10 centimetres (four inches) (see Figure XXII). Post-operative convalescence was uneventful, except that auricular fibrillation was present for twenty-four hours after operation. Four months later the patient had gained 12·6 kilograms (two stone) in weight and had returned to work, though he was handicapped by signs of slight parathyreoid inefficiency.

POST-OPERATIVE TREATMENT.

If the pre-operative treatment has been adequate, and if the operation has been devoid of untoward incident, there should be very little trouble in post-operative treatment. All the difficulties in this series of cases have been traceable to errors in preparation or technique.

When the patient is returned to bed after the operation, the head is elevated on four or five pillows and one pint of saline solution containing 40 drops of Lugol's solution is administered *per rectum*. Pain is relieved by hypodermic injections of morphine. The drainage tube is removed twenty-four and the skin clips seventy-two hours after operation.

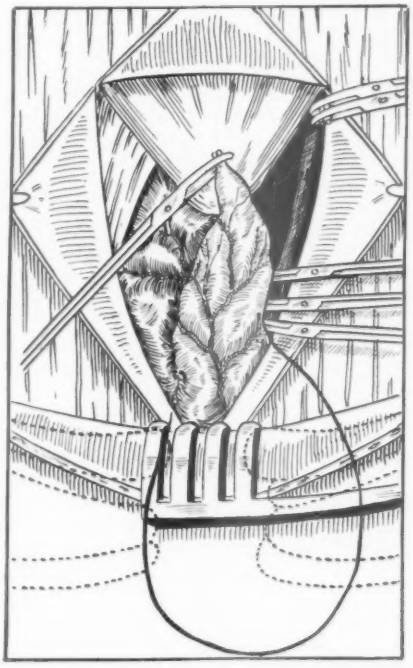

FIGURE XVI. The upper pole is drawn towards the middle line and the middle thyreoid veins are divided. An incision through the posterior aspect of the cervical portion of the gland is then begun from the outer side.

Segall and Means,[14] quoted by Starr,[15] have shown that the immediate toxic effect of thyreoidectomy, which they believe to be similar to a post-iodine crisis, is complete in ten days, so that full doses of iodine must be continued during this period. Though the optimum period for continuing iodine after operation is uncertain, it should probably be given for not more than two or three weeks. Further iodine medication must be a matter for the discretion of the surgeon, but it has been shown that after satisfactory operative treatment the metabolic rate will be normal one month after operation, even if no iodine has been given, while, in a few cases, continued administration of this drug may cause a myxœdematous state, which may be relieved by stopping the iodine or may require the administration of thyreoid extract (Thompson *et alii*[16]).

In some cases, particularly those in the nodular toxic group, subthyreoid symptoms appear even when no iodine has been given, a fact which emphasizes the importance of post-operative supervision of all patients for a considerable time.

FIGURE XVII. The isthmus is divided between forceps. When this has been done, the incision through the posterior aspect of the cervical portion of the gland is completed from the inner side. The inferior thyreoid vessels are caught as this incision is made.

The treatment of a severe post-operative crisis consists in the administration of very large doses of iodine, up to 20 or 24 cubic centimetres (five or six fluid drachms) in twenty-four hours, by mouth or *per rectum*, morphine, fluid in large quantities and frequent sponging to reduce the hyperpyrexia. If the patient will not swallow, fluids should be administered by a nasal tube. In severe cases in which enough fluid cannot be given by the above methods, the subcutaneous injection of saline solution in large quantities is preferable to intravenous injection, as it is free from the risk of overloading a damaged myocardium.

OPERATIVE MORTALITY.

Operative mortality is considered in terms of patients, not of operations. There were six deaths in 348 cases, a percentage mortality of 1·7. The relative mortality in the various groups is shown in Table II.

There was a striking difference between the death rate in the patients operated upon in the Melbourne Hospital and that among the patients treated in private practice. Four deaths occurred among 124 patients

TABLE II.

Group.	Cases.	Deaths.	Percentage.
Exophthalmic	242	4	1·6
Nodular toxic	101	2	1·8
Toxic single lump	5	0	0

operated upon in the Melbourne Hospital, a percentage of 3·2, whereas there were only two deaths in 224 cases operated upon in private practice, a rate of 0·9%. There have been no deaths in the last 120 patients operated upon in private practice. The reason for this discrepancy is not far to seek, for it is generally recognized that the success of surgical treatment in this disease depends just as much upon the efficiency of his assistants as upon the skill and judgement of the surgeon. Further, in order to obtain the best results, there must be daily, and in some cases hourly, personal supervision of patients suffering from toxic goître. The patients in the private group, with the exception of seven, were operated upon in one hospital, in which the theatre staff and the nursing staff were specially trained for the purpose. Changes in personnel were reduced to a minimum, so that waste of time and irritation, due to ignorance on the part of the assistants, were avoided. In a public hospital there are constant changes in the personnel of the assistants and, perhaps an even more important factor, it is impossible, under present conditions, to give the same personal supervision to the patients of this group. The two deaths occurring among the private patients were due to post-operative crises in patients in whom a resection of one lobe had been performed in one eight and in the other two years previously. In both cases iodine had been given for prolonged periods and, further, the long duration of the toxæmia had seriously impaired the heart and other organs. Both goîtres were exophthalmic in type. These cases illustrate the importance of performing a bilateral resection, if necessary in stages, when these patients are first subjected to operative treatment. In the public hospital series, one death was due to post-operative hæmorrhage which was not recognized by the house surgeon until just before the death of the patient. It is interesting to note that this was the only case in which catgut was used to ligate the thyreoid

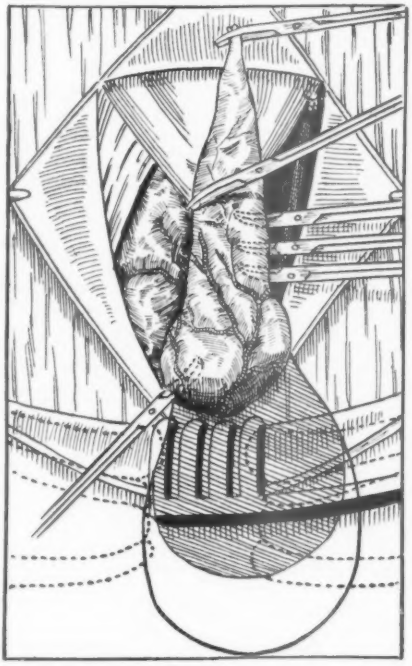

Figure XVIII. The cervical portion of the lobe has been separated from its attachments. The mediastinal extension is being drawn up into the wound. Vessels are clamped as they come into view.

gland vessels. In the second case, a nodular toxic goître, the immediate post-operative condition was very good, but, six hours later, the patient suddenly died when being lifted up in bed by the nurse. It is probable that in this case the importance of the presence of marked dyspnœa on exertion was not fully appreciated. An advanced myocardial degeneration was found at autopsy. The third case illustrates the importance of concealing the time of operation from the patient.

The patient, a mentally deficient girl suffering from exophthalmic goître, was transferred to a surgical ward two days before that fixed for the operation, with the result that she became almost maniacal, and was given large doses of various

FIGURE XIX. X ray picture of intrathoracic goître in Case II. The trachea is displaced to the opposite side. (X Ray Department, Melbourne Hospital.)

sedatives. The surgeon was, unhappily, kept in ignorance of this development until after the completion of the operation. Death occurred two days later from a severe post-operative crisis.

The fourth death was not, strictly speaking, due to the operation.

The patient had a nodular goître for twenty years, and was admitted with heart failure. Her systolic blood pressure was 205 and her diastolic pressure 155 millimetres of mercury, and there was fluid in both pleural cavities. After

the administration of digitalis and aspiration of the fluid, she recovered sufficiently to render justifiable an operation in the forlorn hope that her heart muscle might not be too seriously damaged to permit of improvement. She stood the operation better than was expected, but died of a recurrence of heart failure eleven days later.

It seems justifiable to assume that probably two of these deaths would not have occurred in private practice, for, under proper supervision, in one case the hæmorrhage would have been recognized and treated at an early stage, and operation on the patient who later became maniacal would have been postponed until a more suitable time. These cases illustrate the importance of continuous personal supervision. If they are excluded, the mortality in the public hospital group closely approximates to that in the private group of cases.

FIGURE XX. Case II. Photograph of intra-thoracic goître after removal.

COMPLICATIONS AFTER OPERATIVE TREATMENT.

Hæmorrhage.

Hæmorrhage occurred in five cases. In one, referred to in the preceding section, it was unrecognized and was fatal. In the last 150 cases it has occurred only in one, a fact due probably to the introduction of the practice of placing mattress sutures in the small portion of gland left after resection. It is unnecessary either to move the patient to the theatre or to administer an anæsthetic in order to cope with this complication, for it is a simple and comparatively painless procedure to remove the skin clips, catch and tie the bleeding point and insert fresh clips in the skin edges. This is due to the fact that the superficial nerves are divided in the process of reflection of the skin flaps. If the hæmorrhage be treated in this manner, there is usually no delay in post-operative convalescence. No patient should be left unattended for a minute during the first twelve hours after operation (the period when hæmorrhage most commonly occurs).

Injury to the Recurrent Nerves.

Fairley[17] has shown that pre-operative laryngeal paralysis was found in 3·2% of 353 cases of toxic goître. This is due to the effect of pressure or traction exerted by the enlarged gland, and, in the great majority of cases, disappears after removal. No patient with goître should be submitted to operation without a preliminary examination of the larynx. The incidence of post-operative palsy varies greatly in different clinics. This complication can be avoided only by gentleness in manipulation and by planning the operation in such a manner that the tissue in the vicinity of the nerve is disturbed as little as possible. It is very undesirable to see the recurrent nerve during the course of the operation. Even when every care is taken to avoid direct injury to the nerve, a palsy, due probably to the pressure of the post-operative exudate, sometimes occurs, but is, fortunately, transient. Permanent paralysis of one cord was found in five cases in this series, an incidence of 1·4%. There were no instances of that most serious complication, a bilateral cord palsy. In this condition, both cords are paralysed in adduction, often producing such respiratory obstruction that a tracheotomy is urgently necessary to prevent death from suffocation. The larynx has a very delicate mechanism, so it is not surprising that some alteration in the voice was present in many cases in which, on examination, the cord movements were perfect. This defect is not permanent, but is sometimes annoying to the patient. In one patient, an actress, a normal singing voice was not restored until over twelve months after the operation, though examination of the larynx revealed nothing abnormal.

FIGURE XXI. X ray picture of intrathoracic goître in Case III. Lateral view. Note that the goître extends below the aortic arch and that it is posterior to the trachea. (Melbourne Radiological Clinic.)

Injury to the Parathyreoid Glands.

Pre-operative investigation for signs of latent tetany should always be made, for, as Kanavel[18] has shown, these are not infrequently present before operation. It will have been noted that calcium is given as a routine before operation in this series. Minor signs of parathyreoid deficiency, such as a feeling of "pins and needles" in the extremities and slight muscle cramp, are not very uncommon after operation, but, fortunately, yield readily to the administration of calcium. These signs were more marked in one case of intrathoracic goître to which reference has already been made. In one other case in the series, epileptiform convulsions, apparently due to parathyreoid deficiency, occurred seven days after operation, but subsided after the intravenous injection of calcium chloride. The details are as follows.

FIGURE XXII. Case III. Photograph of intrathoracic goître after removal. The pointer indicates the junction of cervical and mediastinal portions.

CASE IV.—A female patient, aged thirty-one years, was seen on October 27, 1927. This patient had suffered from the typical symptoms of exophthalmic goître for six years. Three years ago the right lobe of the thyreoid had been removed in another clinic. The symptoms had been relieved temporarily, but had recurred in a severe form six months ago. The right recurrent nerve had been injured at the first operation, as, on examination of the larynx, there was sluggish movement of the cord on that side. There was no evidence of parathyreoid insufficiency before resection of the left lobe, which was performed on November 18, 1927. Seven days after this operation, the patient developed symptoms resembling a *status epilepticus*, for eight generalized convulsions occurred in the space of one hour. Neither Trousseau's nor Chvostek's sign could be elicited. Despite this fact, an intravenous injection of 25 cubic centimetres of calcium chloride was given, with the result that the convulsions ceased immediately and permanently. Calcium lactate was administered daily

for six weeks. There has since been no return of the convulsions nor has any other sign of parathyreoid deficiency developed. There was no antecedent history of convulsive attacks in this case.

It is of interest to note that a removal of one lobe had been performed in another clinic in the two cases in this series in which marked signs of parathyreoid insufficiency were seen. Under these circumstances, it is impossible to standardize the removal of thyreoid tissue, an additional argument in favour of a bilateral resection when the patient is first seen by a surgeon. It is probable that in both cases the right lobe had been completely removed together with the parathyreoid glands in its vicinity.

Boothby[19] states that it may be assumed that the acute stage of post-operative parathyreoid deficiency has passed into the chronic stage if, at the end of two weeks after operation, cessation of calcium administration is followed by a recurrence or persistence of the symptoms. It is necessary to be certain that the symptoms are persistent, so that there must be a repeated occurrence of the characteristic spasms, together with either a further drop in, or a continuance of, a low serum calcium content. Having thus determined that a chronic state of parathyreoid deficiency is present, the treatment should be the administration of calcium lactate 2·0 grammes (thirty grains) in water four to five times a day, together with 8·0 cubic centimetres (two fluid drachms) of cod liver oil or ten drops of irradiated ergosterol daily. If, on this regimen, the patient becomes more irritable, does not regain strength and is easily fatigued, and if at the same time there is a peculiar pasty or œdematous appearance suggesting myxœdema, without, however, a lowering of the basal metabolic rate, together with a serum calcium content persistently below 7 or 8 milligrammes per 100 cubic centimetres, the regular administration of parathormone should be begun. As in all deficiency diseases, medication must be continuous and regular. In general, the dose of parathormone should be not more than five units daily or ten units every second day, for larger doses, though safe for a short period, can be harmful if continued for any length of time. Under this treatment, patients with severe or even complete parathyreoid insufficiency can be maintained indefinitely in good, if not perfect, health. In less severe cases, this result can be achieved with calcium and irradiated ergosterol or cod liver oil without parathormone.

Recurrence of Toxic Symptoms after Operation.

Recurrence of toxic symptoms after operation is due, in the majority of instances, to an inadequate resection of the gland, the portion left *in situ* subsequently enlarging with a recurrence of the thyreotoxicosis. As has been stated, this condition is more likely to follow a bilateral resection performed in two stages. In four cases of this type a third operation was necessary. In six cases in which a one-stage resection was performed, there has been a moderately severe relapse into a thyreotoxic state. It is in cases of this type that irradiation with deep X ray therapy is of value in treatment, as it seems to act better on the small

hyperplastic portions of thyreoid tissue left after operation than on the larger complete gland before operation has been performed.

Post-Operative Subthyreoidism.

Post-operative subthyreoidism, requiring the administration of thyreoid extract, occurred in thirty patients. The incidence was much more marked in the nodular toxic group. It was a deliberate policy in all cases to insure, if possible, a cure of the hyperthyreoidism by an extensive resection. After all, there is a satisfactory medical treatment for subthyreoidism.

Pathological Report on 79 Thyreoid Glands.

(Professor P. MacCallum.)

Up to the present, tissue removed by Mr. Newton from 79 thyreoid glands has been examined microscopically.

Attention was directed specially to the frequency of the association of proliferative and functional activity estimated on histological architecture and the cytology of the epithelium, with toxic manifestations clinically recorded.

The macroscopic and microscopic findings were noted independently and afterwards compared with the clinical records.

The Material.

The cases were clinically divided as follows:

Exophthalmic Goître.	
Severe	36
Moderately severe	15
Mild	2
Total	53
Nodular Toxic Goitre.	
Severely toxic	9
Mildly toxic	12
Total	21
Clinically benign ("adenoma")	5

Of the eight males in the series, seven appear in the "exophthalmic" group and one in the mildly toxic nodular group. Of the 71 females 46 appear in the "exophthalmic" and 25 in the "adenoma" groups.

None of the "nodular" group showed adenomatous development in the neoplastic sense. The isolated nodules so described were associated with degenerative changes and fibrosis, and characteristically in these cases the history of the period of goîtrous enlargement was long. It will be seen, however, that in this group the majority contained tissue classed as possibly active.

In only one case of an "adenomatous" gland was exophthalmos recorded.

The Investigation.

The histological categories adopted are: (i) "active", where the proliferative and cytological activity is prominent, (ii) "possibly active", where on the assumed correlation standard there may be any doubt at all that the degree of activity is significant, (iii) "inactive", where proliferation appeared to have ceased and the epithelium to be inert. The features of proliferation (papillary and alveolar) and cytological activity were found to vary together.

The examination showed that of the glands from "exophthalmic" cases (53):

42 were "active".
8 were "possibly active".
3 were "inactive".

Of the three "inactive" glands, one was clinically severe, the remaining two of mild toxicity.

Similarly, the "nodular" cases (26) became divided as follows:

1. The severely toxic group. Of these:
   1 was "active".
   8 were "possibly active".
   1 was "inactive".
2. The mildly toxic group. Of these:
   1 was "active".
   6 were "possibly active".
   4 were "inactive".
3. The clinically benign group, removed for other reasons than toxicity. Of these:
   None were "active".
   3 were "possibly active".
   2 were "inactive".

Comment.

The correlation in the toxic "exophthalmic" group is, somewhat against expectation, high (79·2%). In no case did a gland histologically classified as "active" fail to correspond with clinical activity. In one case only did a gland from a clinically severe case of "exophthalmic" type fail to present the histological features of the "active" group.

There is, moreover, a fair presumption of correlation in a number of members of the "possibly active" group, so that a less exacting classification would give a yet closer approximation (up to 94·3%). Gradation according to clinical severity within the "exophthalmic" group was not attempted. The advisability of applying the severer test is seen in the clinically benign group, three of which are "possibly active", though the modifying factors difficult of assessment, such as degeneration, encapsulation, limited bulk of active tissue, probably operate in these cases.

The only other apparent exception (perhaps not really so) is one classified as mild "nodular toxic goître". This patient, who had been

operated on twice previously, presumably with insufficient removal of tissue, possibly should be placed in the more toxic group.

The "nodular toxic" group presents a less obvious relationship on account of the difficulty of assessing the fibrosis, destruction, degeneration, activity and absorption and the significance of the consequent variation in structure in different sections. This, however, is in keeping with the longer histories, the symptomatic accompaniments and the frequency with which the relative importance of pressure is stressed as a clinical feature (46%). The element of destruction constitutes the main differential feature of the "nodular" from the "exophthalmic" groups.

It was found that the estimate of the probable clinical character of the case from the macroscopic appearance of the glands was also surprisingly accurate.

The amount and condition of the colloid was of little help. A gland uniformly distended with colloid and weighing 481 grammes (seventeen ounces) was clinically of "exophthalmic" type and histologically "active".

The incidence and amount of lymphocytic tissue in the series did not appear to have any correlative significance. Two glands showed excessive infiltration with lymphocytes, one in the severe "exophthalmic" group and one in the mildly "nodular toxic" group. Proliferation and cellular activity predominated in the first. Glandular destruction and fibrosis predominated in the second.

It is perhaps to be noted that in a limited operative series the few benign cases are relatively incidental and cannot be regarded as providing an adequate control in themselves.

As far as it goes, the series is evidence of a direct relationship between the histological and clinical pictures. This relationship is more easily shown in the diffuse hyperplastic than in the focal degenerative group, whose histology and history suggest the operation of factors intimately associated with the processes of retrogression.

The criterion necessary for determining the significance of the histological picture is reliability of the clinical estimate of the disease. It would appear from the above that increased rigour in the clinical estimate was responsible for the corresponding certainty of the pathological diagnosis.

Summary and Conclusions.

1. The material consisted of a consecutive series of 348 cases operated upon by one of the authors (A.N.).

2. Toxic goître is classified into the following groups: (*a*) exophthalmic goître; (*b*) nodular toxic goître, with and without antecedent acute signs; and (*c*) the toxic single lump.

3. A clinical description of the typical signs and symptoms of each group is given.

4. It is emphasized that the various clinical pictures are manifestations of one disease, in which many different combinations of symptoms may occur.

5. The significance and treatment of cardiac arrhythmias, with and without heart failure, are discussed.

6. In considering pre-operative treatment, particular attention is directed to the use and misuse of iodine.

7. It is believed that preliminary operations for the removal of septic foci are unwise.

8. Adequate operative treatment must entail an extensive bilateral resection of the thyreoid gland, which should be performed, if possible, in one stage.

9. The technique of this operation is described, together with the modifications necessary in the presence of an intrathoracic goître.

10. Attention is directed to the use of iodine after operation.

11. The operative mortality was 1·7%.

12. The incidence and treatment of post-operative complications are given.

13. Pathological examination of a series of 79 glands showed a marked relationship between the histological and clinical pictures. This is thought to be due to increased rigour in the clinical estimate of toxicity.

ACKNOWLEDGEMENT.

No article written in Melbourne on toxic goître would be complete without a grateful acknowledgement of the valuable work done here by T. P. Dunhill. Owing largely to his influence, the great majority of medical practitioners advise, and their patients willingly and cheerfully undergo, operative treatment for this disease.

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OSTEOCHONDRITIS, AND IN PARTICULAR OSTEOCHONDRITIS DISSECANS.

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PRECIS.

1. Osteochondritis in general.
2. *Osteochondritis dissecans*:
   (*a*) In the early stages the lesion is subchondral.
   (*b*) There is no evidence at any stage of disease or degeneration.
   (*c*) The initial lesion is probably a subchondral fracture.
   (*d*) By protecting the fragment from undue movement it may in some instances at least be induced to reunite with the condyle.
   (*e*) The supposition that the fracture is produced by external violence acting through the patella supplies a satisfactory explanation of occurrence of the condition in the three recognized sites, namely, the medial condyle, the lateral condyle and the patella.
   (*f*) Subchondral fracture in the condyles may be produced experimentally by pressure or by impact through the patella, but only in immature bones.
3. All the non-inflammatory "osteochondritides" are probably initiated by subchondral fractures.
4. In order to conform to the modern trend of nomenclature, the term *osteochondrosis traumatica* might be substituted for "osteochondritis".

INTRODUCTION.

OSTEOCHONDRITIS is a term which has been applied rather loosely to a number of allied conditions which occur in the epiphyses of some of the long bones, in certain of the bones of the tarsus and carpus and in the bodies of the vertebræ. These conditions have nothing in common with syphilitic and septic osteochondritis, of which the history, signs, symptoms and course are well known. Osteochondritis, for want of a better name, appears in the head of the femur, the condyles and the patella, the epiphysis of the tubercle of the tibia, the tarsal navicular, the epiphysis of the calcaneus, the capitellum, the lunate bone and the bodies of the vertebræ. It is significant that these are all bones or portions of bones which are subject to severe strain by the pull of powerful muscles, or to injury by impaction.

The condition is much more frequent in males than in females, and in the majority of cases appears to have its inception in the second quinquennium of life. There is rarely any definite history of injury. The signs and symptoms are not very notable; there may be some aching after exercise, tenderness on pressure and fluid effusion, with, in the more acute cases, some muscular spasm. There is a strong tendency towards spontaneous recovery, sometimes with some deforma-

tion of the affected bone, as in the femoral head and the tarsal navicular. In the femoral condyles and the capitellum, however, the condition frequently leads to loose body formation.

The X ray appearances provide very startling evidence of bone changes which would appear to merit far more definite signs, symptoms and disability than actually occur. The early X ray changes are apparent fragmentation of the bony nucleus, with subsequent patchy decalcification and sclerosis. There may be a considerable degree of deformity, as in the femoral head; there may be a notable condensation, as in the tarsal navicular and the vertebræ; there may be loose body formation, as in the knee and elbow joints; or there may be recovery without stigma, as in the epiphyses of the tubercle of the tibia and the calcaneus.

The pathology is quite obscure, the more so as few cases come to operation or to the *post mortem* table. The recovery from a femoral head of a low virulence staphylococcus has been reported, but the observation has never been confirmed. Phemister at operation removed part of an affected femoral head, and found in it granulation tissue and a number of small sequestra. Cultures prepared from the excised tissue were uniformly sterile, and microscopic examination revealed only such inflammatory changes as would be consistent with a non-bacterial cause, such as trauma. The condition is not found more frequently in association with congenital syphilis, or with constitutional bone disorders, such as rickets, osteomalacia *et cetera*. Altogether, the suffix itis seems to be quite unjustified, and a new name is urgently required.

Many theories have been propounded to account for the condition—pure trauma, trauma interfering with the blood supply, "quiet necrosis", infection by organisms of low virulence, such as non-pyogenic cocci, or the tubercle bacillus, constitutional bone disorder—all have their adherents and their opponents. The traumatic theory is obviously the most attractive, having in view the robust health of most of the subjects, the absence of suppuration and the tendency towards spontaneous recovery. Objections to the traumatic theory, however, have been considerable and weighty. The absence in most cases of any history of definite injury, the insidious nature of the onset and the mildness of signs and symptoms, make it difficult to explain the condition on a traumatic basis unless the original trauma is of a minor degree, its effects being intensified by the continuance of strain, such as weight-bearing, free movement or the action of powerful muscles.

A subchondral fracture is such a minor injury, and in this paper an attempt is made to show that the characteristic condition in the knee joint can be explained on this basis. The similarity of the history, signs and symptoms, X ray appearances and course in all the "osteochondritides" make it very likely that all are capable of a similar explanation.

In the knee joint it is the final result of the process—the formation of a loose osteocartilaginous body—which first drew notice to the condition, and it is only of recent years, following the greater use of X rays,

that attention has been drawn to the earlier stages in its production. In order to make the argument coherent, it is necessary to give a general survey of *osteochondritis dissecans* and of the theories regarding its causation.

OCCURRENCE.

Loose bodies derived from the articular surfaces of the bones are usually single, although occasionally there may be up to three or four in one joint. The knee joint is the site of election in 90% of cases, the elbow joint in nearly all the remainder. Isolated instances have been recorded in the ankle joint, and the metatarso-phalangeal joints, with some doubtful ones in the hip and shoulder joints. Occasionally both knee joints are affected in the same patient. Loose bodies occur much more frequently in males than in females—182 to 14 (Phemister[1]), 25 to three (present series)—and are usually noticed in the second or third decade of life. In the knee joint the lateral aspect of the medial condyle, near to, but not actually at the insertion of, the posterior cruciate ligament, is the place of origin of the majority. Occasionally the lateral condyle and the patella are affected. In the elbow joint the capitellum is invariably the source.

Loose bodies appear in the affected joints without apparently sufficient trauma, and this absence of a history of injury has been the stumbling-block over which the adherents of the traumatic theory of production have tripped. Sometimes an injury has been immediately followed by the appearance of a loose body, but at operation the body has been found to bear no sign of recent damage, the injury having apparently merely determined its liberation from its bed in the condyle into the joint space.

SIGNS AND SYMPTOMS.

In the subchondral stage the signs and symptoms are indefinite; there may be some aching pain after exercise and transient effusion. After severance of the cartilaginous bridge these signs and symptoms may be somewhat more apparent, but until the body actually sets out on its free-swimming stage in the joint space they are not of much account. When loose in the joint, the body will produce the classical signs and symptoms of locking, pain, effusion and, if the body be not removed, traumatic arthritis.

HISTORICAL.

The condition of loose body must have been recognized at a very early stage in surgical observation, for the loose body often makes its appearance in the more accessible parts of the joint, from which, however, it may disappear with astonishing ease and rapidity. It is owing to this elusive characteristic that the title of "joint mouse" has been conferred upon the typical loose body in the knee joint.

Monro,[2] in 1726, perceived that corresponding roughly to the size and shape of the loose body there was a hiatus on the medial condyle,

and the obvious inference followed that the fragment was merely a chip struck off by external violence. But against this simple theory was the undoubted fact that in many, indeed in the majority of cases, there was no history of trauma sufficient to produce the necessary separation. Moreover, experimental work upon animals, coupled with experience of patients who actually had suffered such violent injury, showed that an osteocartilaginous fragment detached by external trauma invariably gained a secondary attachment, preferably in the suprapatellar pouch.

Paget[3] applied his favourite theory of "quiet necrosis", but without throwing any light on the problem.

Koenig,[4] in 1888, made a thorough investigation of the condition, laid stress upon the absence in most cases of a history of sufficient trauma, and ascribed the majority to a process which he named *osteochondritis dissecans*. In spite of that resounding christening, the genesis of the condition remained obscure.

Since the appearance of Koenig's paper, there has been a considerable accumulation of theories and explanations, many of which will be briefly discussed below. Phemister,[1] in 1924, made a very clear and very full survey of the various theories, and came to the conclusion that an entirely satisfactory explanation had not yet been offered. He mentions, however, the possibility that incomplete or subchondral fracture may be the solution of the problem, although he adduces many arguments against it. Phemister's article is so comprehensive that any *résumé* savours of plagiarism, and I should like to express here my indebtedness to his work.

CAUSATION.

The current theories of causation, with their chief protagonists and the chief arguments for and against them, are briefly as follows:

1. *Trauma from Without* (Monro). Monro's theory, that the fragment of bone and cartilage was split off by one act of external violence, has already been discussed. In cases where external violence appears to have determined the actual liberation of the loose body from its bed, section shows no evidence of recent bony injury, the body having been lying as it were dormant in its bed and merely awaiting a chance to escape.

Broca[5] believed that repeated small traumatism, too small to produce actual fracture, might result in disturbed nutrition, with subsequent necrosis and loosening of the affected area.

Axhausen[6] considered that trauma might damage the blood supply, with subsequent necrosis of bone.

Ludloff[7] thought that there might be trauma affecting the *arteria genu media*, with an infarct of bone. It has been shown, however, that this is not an end artery.

2. *Trauma from Within*. Barth[8] held that the separation was due to the pull of the posterior cruciate ligament. The ligament, however, is not attached to the cartilage, and experimentally it has been found impossible to detach a flake of bone by traction upon it.

Moreover, this theory offers no explanation whatever of loose bodies arising from sites other than the medial condyle.

Freiberg[9] and Roesner have advanced the theory that the separation is due to the impaction of the tibial spine or intercondyloid eminence on the medial condyle. With an articulated knee joint I have found it impossible to make the tibial spine impinge upon the condyle. Even using the disarticulated bones, it did not seem to me possible that such an impingement could take place. And, as before, this theory would still leave unexplained all but the medial condyle cases.

Kappis[10] ascribes the condition to a tangential impaction, due to sudden weight bearing as the joint is carrying out its final rotatory movement in extension. He endeavours to extend this theory to include loose bodies arising from the patella and the capitellum.

3. *Embolism by Fat or Bacteria* (Buchner, Rieger,[11] Axhausen). There is no evidence in support of the embolic theories.

4. *Local Osteo-Arthritis.* Before the development of the traumatic arthritis which is the sequel to the continual irritation caused by a loose body, there is no evidence whatever in these joints of any inflammatory or degenerative change.

5. *Constitutional Disturbances Involving Bone.* Fromme[12] considers that the line of separation of the loose body resembles the fibrocartilaginous "zones of transformation" described by Looser[13] in certain nutritional disturbances of bone, such as osteomalacia. The classical loose body, however, has not been described as occurring in association with such diseases. At the same time, one might presuppose a certain excessive brittleness in the epiphyseal bone to account for the liability to subchondral fracture.

The Subchondral Fracture Theory.

As the epiphyseal "nugget" of bone reaches the perimeter of its growth, it forms on its surface a very thin layer of condensed bone, to which the articular cartilage is attached. The cartilage is insensitive, and the underlying bone, devoid of periosteum, has a very meagre nerve supply. Heavy falls upon the knees are common in childhood, but by their configuration the articular surfaces of the condyles are protected from direct injury from without. The patella, on the other hand, gets many hard knocks, and in semi-flexion, which might be called the "position of falling", its medial facet rests accurately on the very part of the medial condyle which is the source of 95% of the loose bodies in the knee joint. The force, transmitted through the patella, and acting through the elastic cushion of the articular cartilage, splits off from the underlying bone of the condyle a chip in much the same way as a blackfellow by pressure with a piece of wood takes a flake off his flint or quartzite block. The elasticity of the cartilage preserves it from splitting with the bone, and thus the subchondral fracture is born. Owing to the almost complete lack of sensation in the region of the fracture, there is little or no disability, and by the time that the bruise on the front of the patella has disappeared, the

accident will be forgotten. It is obvious that occasionally the lateral condyle or the patella itself may suffer the fracture, so that a common explanation is offered for all the cases occurring in the knee joint.

In the elbow joint the head of the radius is the transmitter of force, a fall on the hand driving the radial head against the capitellum and causing the subchondral fracture (see Figure I).

It is possible that some excessive brittleness of the epiphyseal bone may be a predisposing factor in the production of the fracture, but I have been unable to find any useful data on the subject. The fact that the condition is not infrequently bilateral would suggest such an explanation, but in none of my cases has there been any constitutional disorder of bone such as rickets, *fragilitas ossium* or osteomalacia, and in general loose bodies do not appear to be more common in the presence of such conditions. It would seem rather that exposure to rough and tumble games and accidents at a time when the epiphyseal bone has not attained sufficient strength, is a feasible explanation, and this would account for the great preponderance of male over female cases. Phemister's youngest patient was a girl of twelve, mine a girl of nine, so that probably the condition has its origin in the first decade of life.

FIGURE I. Typical lesion in the capitellum. The bony fragment is still lying in its bed. It subsequently became free, and was removed from the anterior part of the joint.

Given the subchondral fracture, with the articular cartilage intact, there would be little, if any, discomfort, the joint would certainly be in use in a very short time, and weight-bearing and movements, with the consequent rocking of the fragment in its bed, would at least in some cases insure non-union of the bony surfaces. Perhaps some of them unite, unnoticed from the first; certainly some of them unite under treatment. Non-union implies a fibro-cartilaginous covering for the adjacent bony surfaces, and this is invariably found. On the epiphyseal side, as in other ununited fractures, is found a band of sclerosis, but in the detached portion, where the bone is for the most part dead, there is of course no corresponding condensation.

CASE I.—A.S., a male, aged twelve years, for six months had been suffering from recurrent attacks of slight effusion into the left knee joint, with slight aching pain. The attacks were brought on by strenuous exercise, but with rest the effusion quickly subsided and in the intervals there was no disability. On examination during an interval, there was no discernible swelling or fluid in the joint, there was no tenderness, and movements were unrestricted. The X ray report was as follows:

> A small but definite pathological lesion in the articular portion of the internal condyle of the left femur. It can be seen in both postero-anterior and lateral films and shows a narrow zone of necrosis surrounded by a somewhat broader sclerotic area, indicating considerable chronicity.

A diagnosis of Koenig's disease was made.

A second film a month later showed the fragment apparently rising from its bed, and in order to anticipate its liberation into the joint cavity, it was decided to perform arthrotomy.

On opening the joint under a tourniquet the cartilage covering the medial condyle appeared to be intact. Pressure over the area indicated as affected in

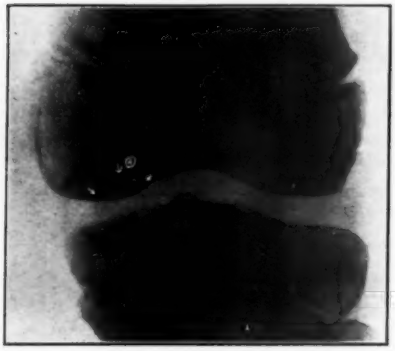

FIGURE IIA.

FIGURE IIB.

Figures IIA and IIB (Case I, A.S.) show the bony fragment lying in its bed in the medial condyle. The zone of sclerosis is easily distinguishable.

FIGURE IIC.

FIGURE IID.

In Figures IIC and IID the bony fragment has the appearance of being extruded. At operation, two days later, the articular cartilage was intact, and the joint was closed without further interference.

the skiagram revealed no undue mobility, but the cartilage retained the impression of the gauze guarding the finger, as if there were some œdema. The joint was closed without further interference, and the wound healed without interruption. Early movement was commenced, but without weight-bearing, and in three weeks a cage was fitted to limit extension at 150°. By this manœuvre the affected area

was protected from weight-bearing, while the nutrition of the parts was encouraged by active use. The skiagrams show the progressive reattachment of the fragment, apparently complete after eight months (see Figures IIA, IIB, IIC, IID, IIE and IIF). Reexamined five years later, the knee joint appeared to be perfectly normal, and X ray examination revealed no trace of the former lesion.

CASE II.—N.W., a male, aged twelve years, had a history exactly similar to that given in Case I. In neither was there any history of definite trauma. On examination there was a small amount of fluid in the left knee joint, no tenderness, and no limitation of movement in any direction. X ray examination

FIGURE IIE.

FIGURE IIF.

Figures IIE and IIF, taken ten months later, the patient having worn a knee-cage which limited extension to 150° during that time, show complete reattachment of the bony fragment.

showed a wide involvement of the medial condyle, the bony fragment being apparently split into two or more parts. The epiphysis of the tubercle of the tibia also showed evidence of fragmentation.

A diagnosis of Koenig's disease was made.

Without operation this boy was put into a cage which limited extension at 150°, and was encouraged to move about. The skiagrams show the progressive reattachment of the fragments complete in twelve months (see Figures IIIA, IIIB, IIIC, IIID and IIIE). At reexamination after three years the knee joint appeared to be perfectly normal.

CASE III.—A.F., a male, aged fourteen years, gave a similar history of recurring effusions without any great disability, and no story of definite trauma. Examination revealed no abnormality except for the presence of a small amount of fluid in the joint. X ray examination showed the typical appearance in the medial condyle.

At operation again the cartilage over the medial condyle was intact, but gave the impression of being slightly œdematous. An incision was made into the cartilage to correspond with the lateral border of the fragment. The line of separation of the bone was discovered, but the bony fragment was so firmly attached to the articular cartilage that the latter was badly damaged in attempting to extract the bone from beneath it. Finally there remained a cavity which bottomed on a layer of firm bone thinly covered with fibro-cartilage. On releasing the tourniquet the bed did not bleed.

FIGURE IIIA.

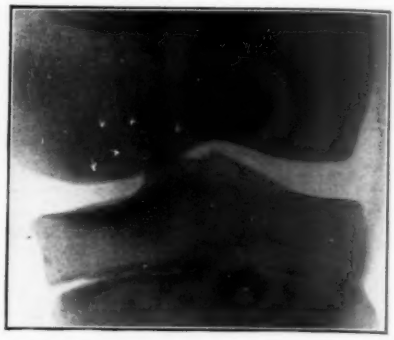

FIGURE IIIB.

FIGURE IIIC.

FIGURE IIID.

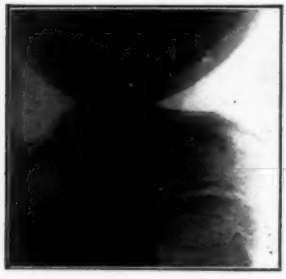

FIGURE IIIE.

Figures IIIA, IIIB, IIIC, IIID, and IIIE (Case II, N.W.). A series of pictures similar to those shown in Figures IIA, IIB, IIC and IID. Figure IIIA shows a considerable degree of fragmentation of the separated piece of bone. Figures IIID and IIIE show the reattachment after fourteen months' treatment in a knee-cage, limiting extension.

Subsequent X ray showed the niche in the condyle from which the fragment had been removed. This patient did not do well, and developed a considerable degree of limitation of movement in the joint, but his parents refused to allow manipulation.

CASE IV.—J.Y., a female, aged nine years, gave an exactly similar history, with no definite trauma. Physical examination was essentially "negative", but the X ray appearances were typical, the lesion being in the right medial condyle. This patient is still under treatment in a cage limiting extension to 150°, but the latest skiagram shows the fragment in process of reattachment (see Figures IVA, IVB and IVC).

FIGURE IVA.

These cases show that in the early stages the lesion is subchondral, and that protection of the affected area from direct weight-bearing may be followed by reattachment of the bony fragment to its bed. Other writers have reported cases in which, although the skiagram shows what is apparently a loose fragment, arthrotomy has revealed an intact articular cartilage (Freiberg, Alwyn Smith[14]). Alwyn Smith's case is similar to those already described, the reproduced skiagram showing beautifully the

FIGURE IVB.

FIGURE IVC.

Figures IVA, IVB and IVC (Case III, J.Y., aged only nine years). Another series of pictures taken at intervals of two months. In Figure IVB there is again an apparent extrusion of the fragment, but in the third reattachment is obviously well advanced. It is interesting to note the more rapid reattachment of the fragment in this the youngest of the three patients.

bony fragment in its bed surrounded by a zone of sclerosis in the condyle, but there appears to be no justification for his conclusion that healing without separation is taking place. By this time the fragment is probably loose in the knee joint.

The question arises, for how long may the bony fragment remain unattached with the articular cartilage still intact? If the condition arises towards the end of the first decade of life, it is probable that ten years is quite a usual time. In Case V, the patient being eighteen years of age, the splitting of the cartilage was undoubtedly recent.

To investigate the possibility of a subchondral fracture of epiphyseal bone I have, in conjunction with Professor Wood Jones, of the University of Melbourne, carried out a number of experiments on the femora of human adults and children and of calves. We have found that in adult bones subchondral fracture is unlikely to occur, the cartilage being

FIGURE VA. This figure shows in the lateral condyle a subchondral crack produced by impact through the patella; in the medial condyle a subchondral fracture produced by direct impact.

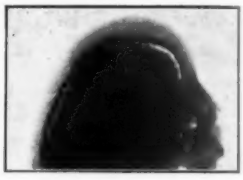

FIGURE VB. Showing subchondral fractures produced by pressure in a vice.

too firm and hard, but in immature bones the fractures are easily produced by pressure in a vice. Frequently the bone may be heard cracking, and the fractures may be seen in a skiagram, while the articular cartilage remains quite intact. It is more difficult to produce these fractures by impact, but I have been successful in producing one quite typical subchondral fracture in the medial malleolus by a blow on the patella. In the femoral head the cracks produced by impact tend to be radial, as would be expected from the shape of the bone, while on the edge of the condyle there is a greater possibility of flaking (see Figures VA and VB).

It seems probable that only for a short period of life is there any tendency towards the production of subchondral fracture in any particular bone, a period which depends upon the size of the epiphyseal nugget relative to the whole mass of the epiphysis. In the femoral head this period appears to be at about seven years of age, in the tarsal navicular somewhat earlier. The epiphyses of the tubercle of the tibia and the calcaneus suffer at about twelve years, and the injury here may be due to the pull of the powerful muscles attached in these situations, or possibly to direct impact from without.

It is difficult to prove that the original lesion is a fracture, for attention is directed to the condition only when it is fully established, by which time all direct evidence of injury, such as crushed or broken trabeculæ, extravasation of blood *et cetera,* has been smoothed away. The absence of any sign of inflammation, however, coupled with the undoubted possibility of reattachment, makes it almost impossible for the original lesion to be anything but a fracture.

The next stage in the development of the fully-fashioned loose body is the splitting of the articular cartilage round the perimeter of the bony fragment. Here there are probably two factors at work; first the slow growth in thickness of the fibro-cartilaginous layers lining the adjacent bony surfaces, which, even in Case I, appears to be lifting the bone from its bed; second, the rocking of the bony fragment by the movements of the joint and by weight-bearing. It is possible that sudden twists or strains or other forms of trauma may cause this splitting, but naturally it is difficult to determine exactly when it takes place.

The splitting may be complete, so that the osteo-cartilaginous body is already "loose", although not free in the joint space. Not infrequently, however, part of the synovial covering of the posterior cruciate ligament remains attached to the upper portion of the fragment, and forms a hinge upon which the body may swing, generally into the intercondyloid notch. This hinge may also provide sufficient blood supply to allow the bone to survive and even to grow.

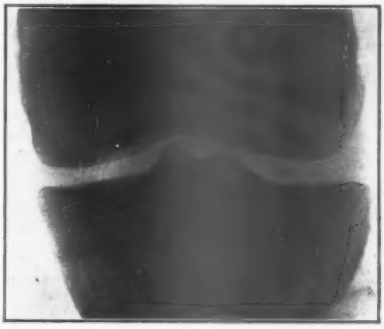

FIGURE VI.

Where the splitting of the cartilage has been recent, the edge is clean and sharp, with no evidence of absorption, but when the body has remained *in situ* for any length of time the edges are rounded off by the invasion of fibro-cartilage.

CASE V.—E.F., a female, aged eighteen years, gave a similar history for four or five years of recurrent effusions and no definite trauma. Three weeks ago the knee had been rather severely wrenched, since when the signs and symptoms had been more defined. X ray examination revealed the typical appearance in the medial condyle (see Figure VI).

On opening the joint the cartilage covering the medial condyle appeared to be normal. On closer inspection, however, a circular hair-line crack was detected in the usual situation, and excentric pressure on the demarcated area caused a typical osteo-cartilaginous body to flip up in much the same way as one saucer flips out of another. This body was clearly awaiting its opportunity to escape into the joint cavity. Section showed a clean fracture of the articular cartilage, without any evidence of inflammation or absorption.

The deep surface of the bony fragment and the bed in the condyle were alike covered with fibro-cartilage, there was no evidence of recent fracture of the bone, and the majority of the bone cells in the fragment were dead.

CASE VI.—H.K., a male, aged nineteen years, gave a history of recurrent attacks of locking, with typical signs and symptoms. X ray examination revealed a loose body lying at the time of exposure in the suprapatellar pouch. In addition, there appeared to be some fragments lying in a bed high up on the anterior aspect of the lateral condyle (see Figure VII).

At operation the loose body was found in the suprapatellar pouch. On the anterior aspect of the lateral condyle, high up and near the border of the articular surface, there was a roughly circular depression. There was a blank space from which the loose body had evidently escaped, and the remainder of the hollow was filled by three other bodies, two of them quite unattached, the third anchored to its bed by some slight fibrous bands. The edges of the articular cartilage were in each case rounded off as if there had been a considerable degree of absorption. Sections of all the bodies showed a central core of bone, apparently dead, a surface of articular cartilage being invaded by fibro-cartilage, and on the deep surfaces a layer of fibro-cartilage. A small piece of the bed removed for section showed cancellous bone covered with a layer of fibro-cartilage.

FIGURE VII. Showing a loose body in the suprapatellar pouch, with another loose body (actually three) still lying in a bed in the lateral condyle. Note the proximity of the patella to the area of detachment.

The site of origin of these loose bodies was on the lateral condyle at a point which corresponded with the upper part of the lateral border of the patella with the knee joint in three-quarter extension. On subsequent questioning, this patient said that he recollected a heavy blow on the knee cap several years ago, but that he had not noticed any disability in the joint until the locking commenced. He was exceedingly vague as to dates.

CASE VII.—W.R., a male, aged fourteen years, gave a history of some aching pain in the right knee joint, with limitation of movement. On examination there was no fluid, no tenderness and no increased temperature in the joint. Flexion was limited by pain at about 90°, but other movements were free. X ray examination revealed some filling of the intercondyloid notch, and a subsequent film, taken at an upward angle, showed a bony mass in the notch.

At operation, by splitting the patella, the intercondyloid region was fully exposed, and a hinged loose body was found lying in the notch. The pedicle appeared to consist of part of the synovial sheath of the posterior crucial ligament, and this pedicle was definitely vascular. The bony fragment was considerably larger than its bed on the medial condyle, and appeared to have gained a secondary attachment to the bone in the intercondyloid notch, from which it had to be detached by chiselling. The bed was filled with fibro-cartilage, which had a mammillated appearance.

FIGURE VIIIA.

CASE VIII.—W.W., a male, aged eighteen years, gave a history of locking, which took place at the lateral border of the patella, and was followed by the usual effusion. There was no history of trauma. On examination there was some fluid in the joint, but no loose body could be felt. X ray examination revealed what appeared to be a vertical fracture in the patella near its lateral border (see Figures VIIIA and VIIIB).

At operation, on opening the joint on its lateral aspect, a hinged body from the lateral part of the articular surface of the patella made its appearance, the hinge being at the lateral margin. Section showed a core of dead bone, with fibro-cartilage covering the deep surface and invading the articular cartilage. The hinge was composed of fibro-cartilage.

CASE IX.—M.F., a female, aged twenty-five years, injured the right ankle two months previously while ski-ing, and since then had had pain and swelling in the joint, mainly about the lateral malleolus. Examination revealed some fluid in the joint, manifested by swelling anteriorly. Movements of inversion and plantar flexion of the foot were limited by pain about the lateral malleolus. X ray examination revealed an old fracture of the lateral malleolus, with an ununited fragment at the tip, at the origin of the anterior fasciculus of the ligament. On the medial aspect of the talus there appeared to be a loose body still lying in its bed (see Figure IX).

Further questioning now disclosed the fact that about fifteen years previously this patient had a severe

FIGURE VIIIB

Figures VIIIA and VIIIB. Semi-detached body on the lateral border of the patella.

fall from a horse and injured the right ankle. This had gradually recovered without any particular treatment, and in the intervening years had not given any trouble. Apparently the recent injury had torn the fibrous attachment of the malleolar fragment.

At operation the malleolar fragment was removed as far as possible subperiostally. The ankle joint was then opened on its anteromedial aspect and two typical loose bodies, still lying in their bed, were removed from the articular surface of the talus. The articular cartilage on the loose bodies and at the edges of the bed had been largely absorbed and replaced by fibro-cartilage, and the condition was certainly of long standing, probably dating back to the injury fifteen years ago.

The final stage, in which the loose body is free in the cavity of the joint, and the bed from which it came is filled with fibro-cartilage, is too well known to merit description. In many cases the actual liberation of the body appears to be due to some trauma, such as a twist or strain, but examination of the loose body itself and its former bed makes it clear that the condition is in reality of long standing.

FIGURE IX. Two loose bodies, still in their bed, on the articular surface of the talus.

CASE X.—H.K., a male, aged twenty-four years, four weeks ago, while playing football, twisted the right knee rather violently. For a week there was a considerable amount of pain and fluid in the joint, and activity was restricted. Since then, on several occasions there had been typical locking of the joint, and on two occasions the patient had felt a loose body to the lateral side of the patella. On examination there was some fluid in the joint, but no other evidence of any pathological condition. X ray examination revealed a loose body in the suprapatellar pouch, and a hiatus on the medial condyle in the usual situation.

At operation the loose body was found in the suprapatellar pouch. The hiatus in the condyle was lined with fibro-cartilage, the edges were eroded, indicating that fissuring of the cartilage had taken place some time previously, but at the upper border was a tag of articular cartilage, partly replaced by fibro-cartilage. The counterpart of this tag was found on the loose body, and evidently it had been holding the loose body in position until it was torn by the injury four weeks ago.

PATHOLOGY.

The loose body of some standing is round or oval, of a size varying from one to three centimetres in its greatest diameter, and with a nodular surface. On section, the original structures will be found to have been largely replaced by fibro-cartilage, which may be irregularly calcified. After separation, the kernel of articular bone, detached from its blood supply, will die, although a small portion may obtain sufficient nutrition from the synovial fluid to survive. The growth of the loose

body in the cavity of the joint, however, is due solely to proliferation of fibro-cartilage, which derives its nourishment from the synovial fluid, and which may undergo various forms of metaplasia. The bed from which the loose body originates, fills, and sometimes overfills, with fibro-cartilage.

A loose body immediately after extrusion from its bed is biconvex or plano-convex in shape. The articular surface is unchanged; the articular cartilage is firmly fixed to the underlying bone, which carries on its non-articular side a thin layer of fibro-cartilage. The edge of the articular cartilage may be cleanly split, without evidence of inflammatory or absorptive change, or there may be some replacement towards the edges by fibro-cartilage with a consequent rounding off of the sharp margin. If extrusion takes place immediately or soon after fissuring of the articular cartilage, the edges will be sharp, but if the body has remained in its bed for some time after the fissuring the edges will be more rounded. On section the bone is found to be, for the most part, dead, although a small part may survive. The bed is lined by fibro-cartilage, the growth in thickness of which appears in some cases to have determined the freeing of the body into the joint cavity. In no case is there to be found evidence of recent fracture or of any inflammatory process, such as is suggested by the word osteochondritis.

In a certain number of cases a few fine fibrils of connective tissue may connect the body with its bed, and in these a larger proportion of the bone cells may survive, deriving some blood supply through these connections. More frequently there may be a vascular hinge formed from the synovial sheath of the posterior crucial ligament, and by this blood supply the bone fragment may survive or even grow. In the majority of such cases the body is extruded from its original bed, and lies in the intercondyloid notch, where it may attain a considerable size.

In cases detected before fissuring of the articular cartilage there is on opening the joint no apparent deviation from the normal. Closer inspection will show, over the area of bony detachment, a slight sponginess of the articular cartilage, which will retain the impression of the pattern of a piece of gauze firmly pressed upon it, much as œdematous skin will retain a picture of the lines and whorls of a finger-tip. Incision of the cartilage will disclose the bony fragment lying in its bed, both adjacent surfaces carrying a thin layer of fibro-cartilage.

Still an earlier stage must exist, when evidence of recent fractures would be forthcoming, and where fibro-cartilage has not yet had time to line the adjacent surfaces, but, up to the present, this stage has not been clinically observed.

X RAY APPEARANCES.

The particular interest in the X ray findings lies in the films showing the early stages of the condition, before separation or extrusion has taken place. In general, these show a bowl-shaped crack in the condyle or capitellum, and the apparently separated portion frequently exhibits fragmentation. This appearance so strongly resembles the apparent fragmentation of the femoral epiphysis in Legg-Perthe's disease

and some of the other osteochondritides that a similar causation suggests itself.

Many of the films show a thin line of sclerosis proximal to the cleft, similar to the sclerosis which occurs near any ununited fracture.

Even before fissuring of the articular cartilage, the film may show quite a noticeable elevation of the edge of the fragment above the general

FIGURE X. Concentric layers of calcification in a loose body.

line of the condyle. The separating "crack" appears to be increasing in width, presumably owing to the proliferation of fibro-cartilage, thus slowly levering the fragment from its bed. In spite of this appearance, reattachment may still occur.

Owing to concentric layers of calcification in the fibro-cartilage, very strange and striking X ray appearances may be produced (see Figure X).

CONCLUSIONS.

A study of the case histories detailed in the text shows that in the early stages the lesion in *osteochondritis dissecans* is undoubtedly sub-

chondral, and that by protecting the affected area from undue pressure and movement the fragment may be persuaded to reattach itself to the condyle. It shows also that during the subchondral stage the signs and symptoms are almost negligible. Pathological examination of the bodies in their various stages fails to disclose any evidence of disease. All this is strong evidence of the original lesion being a fracture, and experimental evidence of the possibility of such a fracture is given.

The assumption that the force is transmitted through the patella offers a satisfactory explanation of the three sites of the lesion in the knee joint. In other joints a similar form of cushioned violence could produce the initial subchondral fracture.

To extend this theory to explain osteochondritis in other situations may seem ambitious, but their similarity to the condition in the knee and elbow joints is not only in name. They show the lack of sufficient trauma, the insidious onset, the rather insignificant signs and symptoms, and the surprisingly definite X ray findings. The fact that a subchondral lesion can exist with such small disturbance to the organism makes it very likely indeed that all these conditions may be explained on such a basis.

In the vertebral bodies there appears to be some confusion of nomenclature, and cases which were previously described as osteochondritis are now denied that title, while the intervertebral disk is coming into a prominence which it does not appear to deserve. It seems more than likely that some of the recondite conditions, such as Kümmell's disease and Köhler's disease, are also the results of minor fractures in the vertebral bodies, the effects of which are intensified and perpetuated by insufficient immobilization, and weight-bearing. Here again the absence of evidence of actual disease, coupled with the tendency to repair and regeneration when the conditions are treated by rest, is strong evidence in favour of a purely traumatic origin.

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RHABDOMYOMA OF THE EXTREMITIES.

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Within a short period there have come under my observation two tumours of the extremities occurring in striated muscle (one arose in the *brachialis anticus* and the other in the gastrocnemius muscle) and having characters which indicate strongly a close relationship with that tissue.

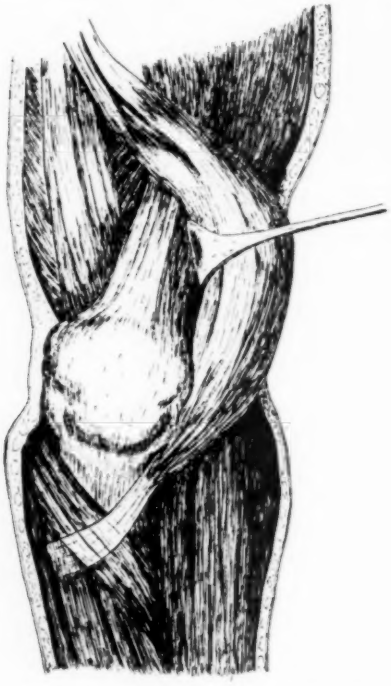

FIGURE I. Drawing of a dissection of the muscles in the region of the front of the elbow joint, showing a tumour of the *brachialis anticus* (after Küttner). The tumour was described as a "sarcoma".

The occurrence of certain tumours with cells whose histology recalls that of cardiac or voluntary muscle, more particularly the cross striation, has been quite frequently recorded, though such tumours are usually considered to be rare. It is convenient, modifying Dewey's classification,[1] to divide them into two groups: (i) Those arising in situations where an origin from striated muscle (absent normally from the part) is improbable. (ii) Those arising in striated muscle.

In the first group the striated muscle is usually associated in the tumour with other tissues, for example, cartilage, epithelium-lined tubules *et cetera*. These growths occur for the most part in the genito-urinary region, and are variously explained as due to "developmental anomalies", "embryonic disturbances" and "one-sided development of a teratoma". They have been recorded also in the parotid gland and the lungs.

The second group includes those cardiac tumours[2] curiously associated with tuberous sclerosis of the central nervous system, tumours in the kidney and *adenoma sebaceum*, of which the records are fairly numerous, and tumours of muscle of skeletal type.

Accounts of tumours of skeletal muscle were infrequent till recently. In 1913 Küttner[3] traced and discussed sixteen examples, of which he rejected six and doubted ten. Burgess,[4] about the same date, mentions only Adami's[5] tumour in a trout. Since then, however, many cases have been described, and there seems little doubt of their origin

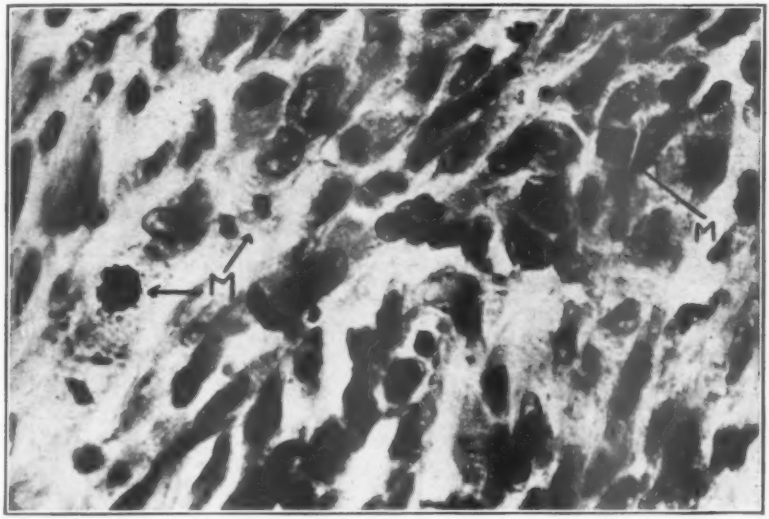

FIGURE II. Photomicrograph of a section of the first tumour removed in Case I. The cross striations of the fibres are visible, and it will be seen that these are present in cells which possess nuclei undergoing mitosis (M). × 700.

and nature. The tongue[6] provides a series of tumours whose descriptions record histological peculiarities apparently characteristic for the region. It is noteworthy perhaps that two of them were associated with syphilitic leucoplakia.[7] Among other sites, the œsophagus,[8] uvula, muscles of the nose, eyelid, orbit, dorsal thoracic muscles, *pectoralis major*, brachialis, triceps, buttock and psoas muscles, muscles of thigh and the gastrocnemius are recorded.

The tumours occur in both sexes. No age is exempt. They may be present at birth (heart, tongue); they may arise in the young (seven months, three and three-quarter years, six and a half years) or the aged.

Association with trauma has been noted in some instances, and Müller[9] records an interesting case following repeated fractures of the femur.

MACROSCOPIC APPEARANCES.

The growths occur as single or multiple nodules varying in size from 1·25 cm. (half an inch) to 10·0 to 12·5 centimetres (four to five inches) in diameter. They are usually rounded, but they may be flattened in their growth between muscle bellies. They usually appear to be circumscribed; even the rapidly growing forms are fairly sharply delimited macroscopically. When they occur in the middle of muscle bellies, they expand these structures in a characteristic manner. If they occur at the edge of the muscle, they grow along it and particularly in the intermuscular septa, so giving rise to the idea which was commonly held until recently, that these growths actually arose in the fibrous tissue.

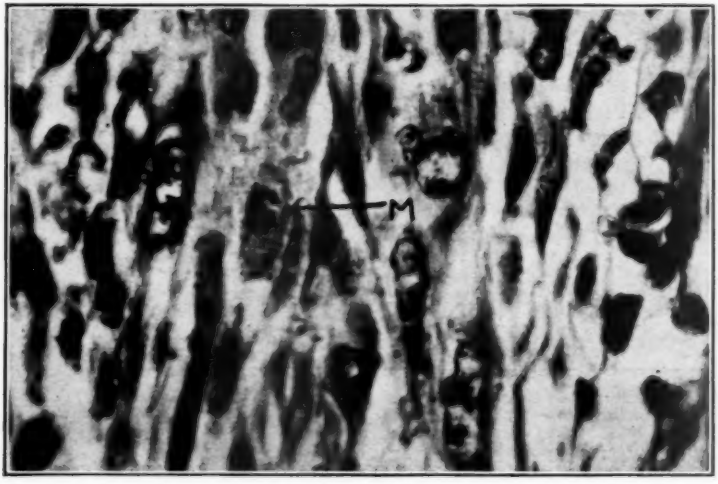

FIGURE III. Photomicrograph similar to that shown in Figure II. Again the cross striations are visible in a cell containing a mitotic figure (M). × 700.

Their consistence, in the absence of degeneration, varies with the type of tumour cells present and with the amount of fibrous tissue. In the slowly growing varieties the muscle-like cells are comparatively well formed, and if these are in excess the growths are tough; the connective tissue also is more abundant, and this gives a hardness to some tumours. In the rapidly proliferating forms the cells are of the "embryonic" type, and the neoplasms are of soft consistence.

On section they are greyish, with yellow or reddish areas depending on vascularity, the presence of necrosis *et cetera*. They appear to be sharply demarcated from their surroundings (see Figure VI). They have a curious opaque appearance and texture which is quite different from that usual in fibrous tissue or smooth muscle tumours. Some of the more slowly growing varieties show a whorling which resembles that

seen in some connective tissue growths. These, however, are the varieties which show the best development of cross striation, so that the diagnosis is made the more easily.

MICROSCOPIC APPEARANCES.

But seldom in these tumours is any approach to the arrangement of voluntary muscle discernible. Though the cells in some areas may be arranged in parallel bundles, in others they interlace. Occasionally a grouping round blood vessels occurs, and tumour cells may actually form the walls of these. Most often the cells are arranged quite

FIGURE IV. Photomicrograph showing another portion of the tumour in Case I. The striations are present in cells which are abutting on a blood space. ×700.

irregularly, though parallel bundles of cells may be seen running through parts of such areas. Cells of a kind are patchily prominent.

The cell constituents themselves present a great variety of form. The majority are of the "embryonic" type. Spindle forms are the commonest and they vary in length and bulk. Round forms are also frequent, some of them probably representing transverse sections of spindle forms. Others are short or elongated bands, some narrow, some wider, expanding even to adult dimensions at the nuclear level, and showing irregular, fibrillar or bulbous ends. An appearance of branching and anastomosis is sometimes seen in these forms. Many giant cell forms occur, rounded or irregular in shape.

The protoplasm is usually acidophile in the striated cells, but in the more rapidly proliferating cells this feature is lost. It is granular

particularly in the region of the nucleus. The striations are similar to those seen in normal muscle cells, the longitudinal ones being usually more marked than the transverse. When cross striations are present, the double spiral character noted by Tiegs[10] may be traced just as in the normal muscle cells. They are developed in varying degree, may reach across the cell only half-way, or be developed at one margin only and extend over little or much of the length of the cell. Occasional irregular arrangements are seen, and in some of the giant forms concentric striations are observed.

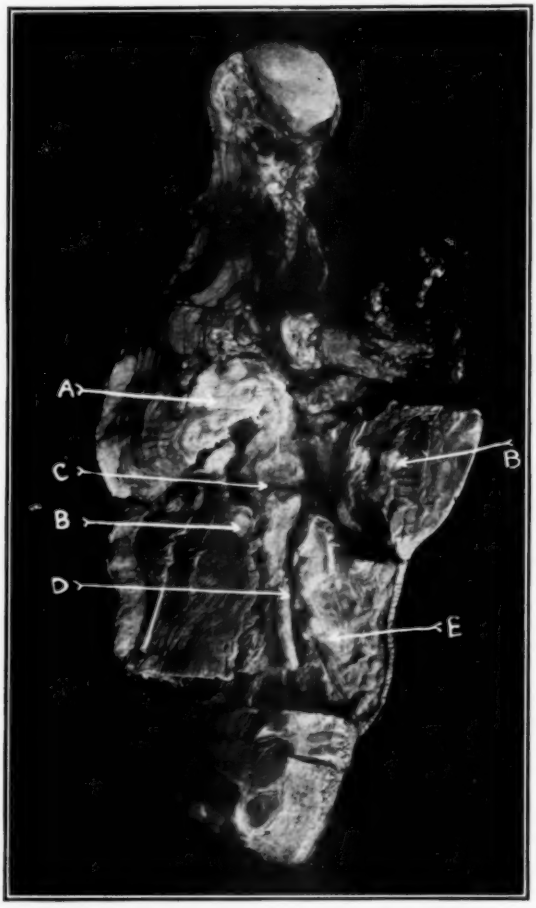

FIGURE V. Photograph of a dissection of the upper arm after amputation (Case I). A indicates a mass of tumour substance invading muscle. B = small nodules of tumour substance. C = site of cut in the humerus to determine invasion of the bone. (It was not involved.) D = line of tumour tissue lying in the intermuscular plane. E = mass of tumour tissue near the original site of the tumour.

The nuclei are large and vesicular, with a deeply staining chromatin network and numerous chromatin knots. They are usually situated in the centre of the cell, but may be marginally placed, and even project at the edge of the cell body. Some of the cells are multinucleated, and some of the giant and atypical cells possess large, distorted, polymorphous nuclei. There is no definite sarcolemma, though indications of its partial development have been described.

In a general way the more slowly growing the tumour, the nearer is the approach to differentiated muscle.

The connective tissue varies in amount; usually it consists of fibroblasts of ordinary appearance in a loosely woven intercellular substance. In intermingling with the cells of the tumour, strands of it may vaguely define groups of cells. With preparations not stained to differentiate collagen, the distinction between spindle-shaped tumour cells and fibroblasts is difficult or impossible to determine. In more cellular areas, particularly at the growing edge, the stroma has been described as sarcomatous and myxosarcomatous. It is probable that many of the cells in dispute are myogenic.

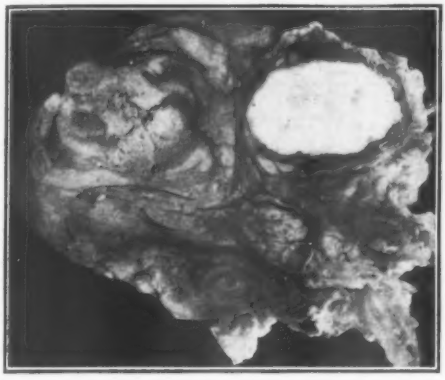

FIGURE VI. Photograph of a mass of fat tissue taken from the axilla showing a tumour nodule. It appears to possess a well-defined margin.

As with other tumours in like circumstances, the secondary growths may faithfully repeat the characters of the primary, or may differ from it by either greater differentiation or more anaplastic form.

MALIGNANCY.

A notable frequency of recurrence is recorded in the accounts of tumours of this group whose course was slow. The apparent demarcation of these growths, perhaps diagnosed as fibroma, encourages hopes of success by local removal. Such removal, though apparently complete, is often followed by recurrence, both at the site of operation and at a distance. The course may be one of appalling rapidity from the beginning.

The spread occurs by infiltration along tissue planes, by way of lymphatics or of the blood stream. Spread along tissue planes is well seen in some specimens where plaque-like masses occur between the muscle bellies (Case I). The dissemination by lymphatics and involvement of lymph glands are notable features of these growths in many of the records. That blood vascular

FIGURE VII. Photograph showing a tumour mass invading muscle.

invasion also plays a part is evident from the records of visceral metastases (lung), and the occurrence is in keeping with the intimate relation of tumour cells to vascular spaces observed in the sections of rapidly growing forms. While metastasis is a feature of some growths, others, while locally recurrent (Case II), yield no evidence even on careful examination *post mortem* of such dissemination.

The two cases here reported illustrate a number of the features of these tumours.

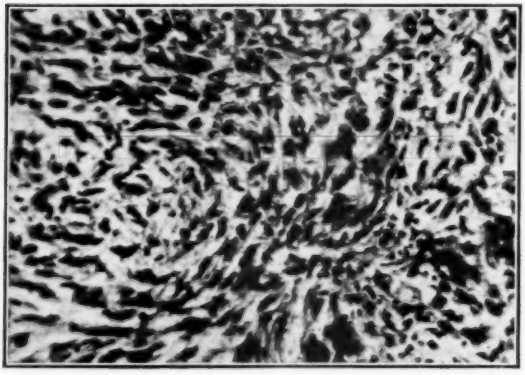

FIGURE VIII. Photomicrograph of the recurrent tumour in Case I. The active character of the cells is apparent. × 180.

CASE HISTORIES.

CASE I.—H.S., a male, aged fifty-nine years, a cook, reported at hospital with a small tumour of a few weeks' duration in the "lower and inner portion of the arm". This was removed apparently completely, and on microscopic examination reported as an "active fibroma".

Six weeks later he returned with a diffuse swelling extending from the region of the elbow almost to the axilla, and doubling the circumference of the arm. This was removed again apparently completely. A further recurrence in the lower portion of the wound three weeks later was removed, but a month later yet another recurrence took place in the upper part of the wound, and there were palpable glands in the axilla. An amputation was performed through the shoulder joint, with dissection of the axilla.

About a month later the patient died suddenly of "pulmonary embolism". From clinical signs before death, the development of metastases in the lung was suspected. An autopsy was not obtained.

The specimen removed at the amputation is shown in Figure V. Nodules of the tumour are seen in the muscles and running up in the intermuscular connective tissue

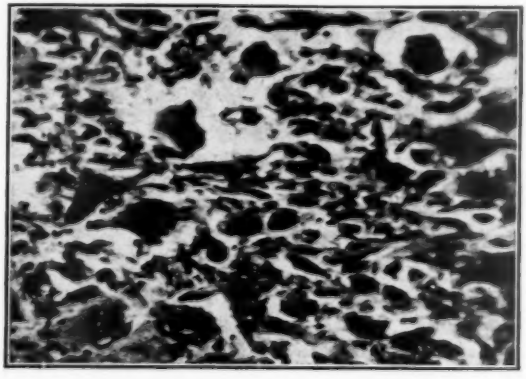

FIGURE IX. Photomicrograph indicating the bizarre character of many of the cells and their nuclei. Case I. × 180.

planes. The bone was not involved. There were nodules of tumour in the fat of the axilla (see Figure VI) and several lymph glands were invaded (see Figure XI).

Microscopic Appearances.—The great bulk of the original tumour consisted of closely packed spindle cells containing oval, often pyknotic, nuclei and many mitotic figures (see Figures II and III). A number of the fibres showed characteristic cross striations when examined by means of critical illumination.

The second tumour consisted of cells which were mainly of the spindle type, but these were extraordinarily pleomorphic and many giant cells of remarkable variety of size and shape with large bizarre nuclei (see Figures VIII and IX).

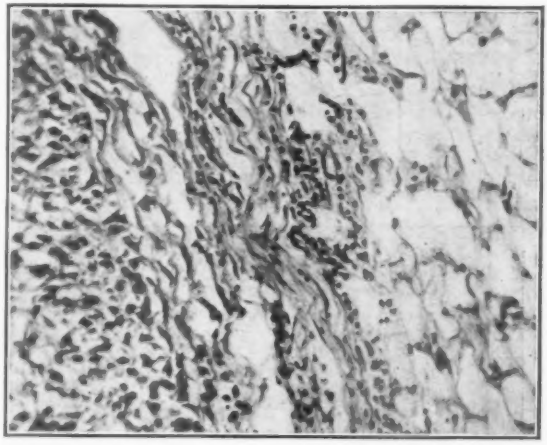

FIGURE X. Photomicrograph showing the invasion of fat tissue by the tumour. Case I. ×180.

A considerable amount of the tissue was necrotic. The tumour invaded the surrounding muscle (see Figure VII) and fat (see Figure X) indiscriminately. Many of the cells showed cross striations. In the giant cells the cross striations were arranged in various directions (see Figure XII). A section of a secondary growth in a lymph gland showed the same characters.

CASE II.—M.M., a female patient, aged seventy years, twelve months before coming under observation had noticed a swelling of the calf of the right leg. This had gradually increased in size, until it reached the size of a tennis ball. It was painless, and its surface was smooth, though slightly lobulated. It was unattached to skin or bone. It was excised and diagnosed as an "active fibroma". The patient was well for eighteen months, when the swelling reappeared, but, since it occasioned little trouble, it was disregarded.

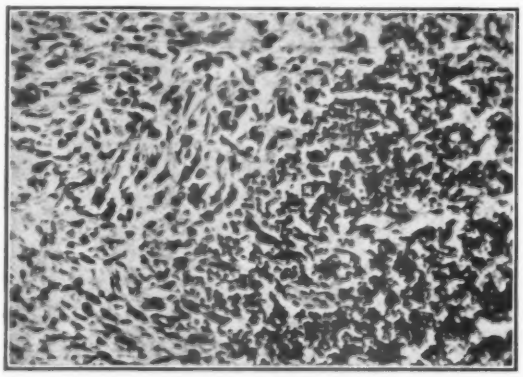

FIGURE XI. Photomicrograph of a section of a lymph gland. Case I. The gland has been replaced almost completely by the tumour tissue. ×180.

Two years later she was readmitted to hospital, having a large tumour of her right calf. This consisted of a lobulated mass of

tissue measuring about 15 centimetres (six inches) vertically, 8·75 centimetres (three and a half inches) laterally and bulging the calf for about 6·25 centimetres (two and a half inches) posteriorly. Enlarged veins ran over the bluish surface. It was soft, semifluctuant and unattached to bone, but adherent to the skin. Two months after the patient's admission to hospital the growth ulcerated through the skin. Two months later the patient died.

The *post mortem* examination showed the tumour described involving the muscles of the calf, but not invading bone. On section, the tumour had a uniform homogeneous greyish-white appearance. In some areas some slight degree of whorling was present, but the bulk of the tissue was characteristic. There were no metastatic growths.

Microscopic Appearances.—In the primary growth the tissue consisted of elongated spindle cells, arranged in groups, some cut longitudinally and others transversely. Ordinary connective tissue was present between these cells, in some

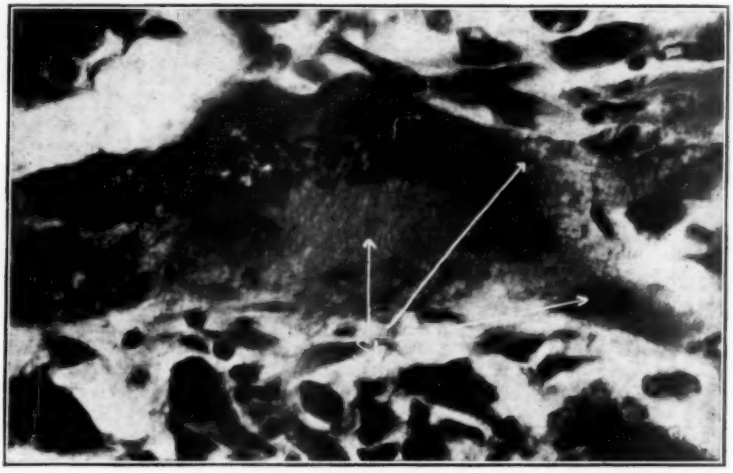

FIGURE XII. Photomicrograph of one of the giant cells of the tumour in Case I. Striations irregularly placed are present even in these cells. The poorly marked character of these striations is due probably to late fixation. × 700.

of which a few striations could be seen. In the recurrent growth the tissue consisted, for the most part (see Figure XV), of numerous spindle and round cells intermingling. In certain areas there was an extraordinary variation in the size, shape and staining qualities of the cells. The nuclei showed much variety in size and shape and chromatin content. Many mitotic figures were present. The tissue was very vascular.

At first the diagnosis of muscle origin was not made. When the material was examined with the use of critical illumination, however, it was shown that many of the cells, even the giant cells, contained cross striations.

The tissue in both cases was fixed in formalin. Hæmatoxylin and eosin, Van Gieson's stain, Mallory's phospho-tungstic acid hæmatoxylin and silver impregnation were the staining agents used. The opportunity to apply staining methods for demonstrating glycogen was lost.

DISCUSSION.

The diagnosis of tumours of this group is not always simple. The ease with which the special features of the group are detected varies considerably with the specimen, and since the criterion frequently demanded before an origin from muscular tissue will be admitted is the demonstration of the characteristic cross striations, it is not at all improbable, indeed is almost certain, that many tumours truly of such origin or character are not recognized as such, and are relegated to the tumour scrap-heap of sarcoma.

FIGURE XIII. Photomicrograph of another portion of the growth. Case I. A characteristic "muscle" cell is present amongst the embryonic cells. × 700.

Anaplasia, in accordance with its degree, in rapidly growing forms removes the criteria of differentiation. The basis of classification in this group is after all not cross striation, but origin from a tissue exhibiting this differentiation. Such an origin has indeed with some reason been claimed for tumours in which cross striations have not been demonstrated.

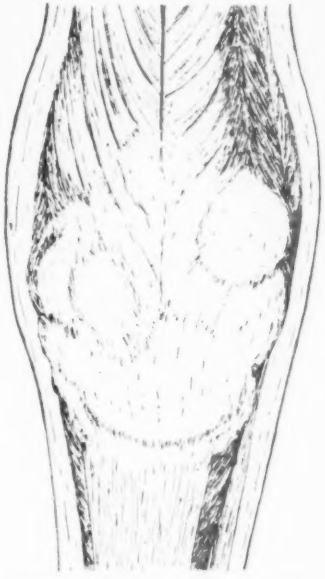

FIGURE XIV. Drawing of the growth in the gastrocnemius muscle. Case II.

The postulate that the potential for such differentiation may exist in cells not recognizable as muscle, introduces further possibilities for consideration. It is maintained that such cells do occur in muscle, and may give rise to tumours with striated cells. Most important also is the behaviour of true muscle fibres in adverse conditions. They may lose

striations, form spindles, narrow bands and aberrant shapes, alter in staining character, become vacuolated; show multiple grouped nuclei, bizarre "giant" nuclei, regular and irregular mitoses. Moreover, when muscle tissue is being invaded, greatly altered muscle tissue may be found at unexpected depths in the tumour mass and produce a very faithful appearance of "transition" to the tumour form. Like problems are met with constantly where the invading and invaded tissues are closely related, notably, for example, in the gliomata. Indeed, only the maintenance of the differential characters of the tumour cells in a tissue affording obvious contrast clearly resolves such difficulties, and

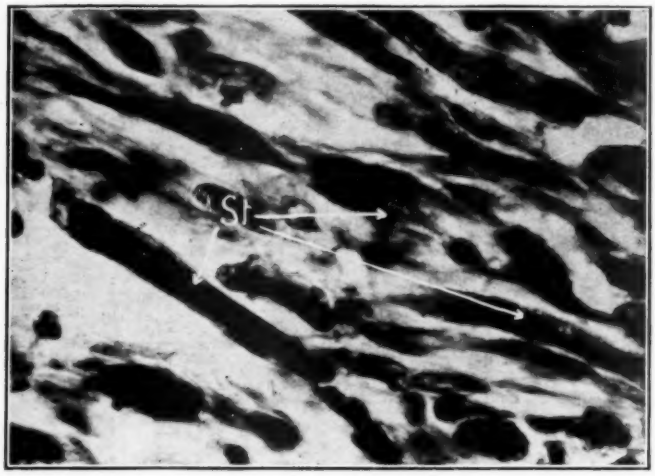

FIGURE XV. Photograph of a section of the tumour taken from Case II. This tumour is more characteristic of striated muscle growths than the previous example, but many areas showed anaplastic tissue very similar to that seen in the other sections. × 700.

enables us to extend experience of such growths by a cytological study in culture, isolated in a more suitable medium for observation.

In addition, there is the fact that secondary changes may modify the tumour cells and obscure their differential characters just as much as those of muscle cells.

It is very probable that tumours taking origin in striated muscle are less rare than is commonly supposed. The same is probably true of tumours of peripheral nervous tissue. Their true nature may very easily be overlooked. It is always necessary to keep the possibility of the establishment of such specific relationships steadily in mind. Mixed, spindle and round-celled sarcomata occurring in any tissue call for critical examination if we are to mitigate the ignorance that induces us to seek refuge in such narcotic nomenclature.

It is noteworthy that the two cases described were both diagnosed when first examined as "active fibroma", a fact which emphasizes the probability that a number of tumours of this type are diagnosed as being of connective tissue origin. The difficulty in diagnosis presented by the associated connective tissue cells and by the alterations in intermingled muscular tissue mentioned above, finds a parallel in bone involvement. Invasion of this tissue by a myogenic tumour is mentioned in the record of a case recently by Hirsch.[11] The similarity in cellular structure to certain bone sarcomata may be extremely close, and the assumption of an origin from bone in the absence of specific differential features in the cells is likely to be made. One such case in which decision is difficult came under observation recently.

The case was that of a young man in whom, following trauma, a very hæmorrhagic tumour, whose main bulk was in the soleus, had softened the uppermost inch of the fibular head. The microscope showed that invasion of the bone was from the surface. In no part examined was there any indication of formative activity of an osteogenic character. There was so abrupt a transition from bone trabeculæ to tumour cells and so close a similarity in the cytological picture to that of anaplastic growth of muscle origin that the diagnosis is still in suspense. The patient has been well for a year after amputation at the hip.

FIGURE XVI. Photomicrograph of an anaplastic area of the tumour (Case II). One cell shows a mitotic figure and the concentric arrangement of the striations. × 700.

Yet another case presents difficulties of its own.

In a woman of seventy-two years, a large rounded tumour of the axillary region was found at autopsy to be not involving breast, bone or lymphatic glands, not in muscular tissue and apparently not attached thereto. A tumour of striated muscle origin in this situation, however, might arise in the axillary muscular arches (pectoro-dorsalis), frequently found connecting the pectoral muscles with the *latissimus dorsi*. Numerous large metastases were present in both lungs, but nowhere else in the body. The microscopic picture of tumour and metastases suggests strongly a myogenic nature, but again no specific characters define its origin.

The undifferentiation in tumours of related tissues must lead at times to a convergence of cytological character that conceivably in the limiting case would lead to a similarity defying possible distinction, that is, to histological identity. Short of this, the approximations present essentially the same problems as those of cytological differentiation in embryology, and our capacity to differentiate them on the demonstration

of the finer points of valid cytological distinction. The two essentials are technique and experience of cytology in all phases. Wolbach[12] has recently attempted to apply improved technical methods to the diagnosis of tumours of this group, and similar attempts may enable us to extend our differential range. Finer cytological work demands fresh tissue and special methods of fixation, and since the useful and inexpensive routine formalin fixation sets a technical limit to the demonstration of histological detail, only where suitable preparation is possible will advance be made in differential finesse.

SUMMARY.

Two cases of malignant rhabdomyoma of the extremities are recorded and the problem of histological diagnosis discussed.

ACKNOWLEDGEMENTS.

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MESENTERIC EMBOLISM: THREE CASES OF RECOVERY.

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THE arrest of a clot in any of the main vascular channels of the body produces profound disturbances, which are manifested to an extraordinary degree when this process occurs in the vessels of the mesentery. To this condition Trotter[1] has given the name "mesenteric vascular occlusion", to denote his belief that the means whereby it is effected are in no way constant. An artery of the mesenteric system may be blocked by an embolus, or it may become gradually thrombosed by a primary sclerosis occurring in its wall. Adjacent septic foci may be responsible for the spreading of a thrombotic process to the mesenteric veins. Any one of these pathological processes may be the underlying factor in the production of the clinical picture of "mesenteric embolism", but this report is concerned rather with those acute abdominal catastrophes where an embolus lodges in the superior mesenteric artery or one of its branches. The embolus apparently consists of detached vegetations from the mitral or aortic valves or atheromatous patches from the aorta. In the majority of cases it lodges in the superior rather than in the inferior mesenteric system. The reasons offered in explanation of this fact are:

1. The proximal origin of the superior mesenteric artery renders it more likely that an embolus will enter its lumen than that of an artery which arises more distally.
2. The calibre of the superior mesenteric artery is greater than that of the inferior mesenteric artery.
3. The superior mesenteric artery, running as it does almost parallel to the aorta, presents its lumen to the blood stream more directly than does the inferior mesenteric artery, which arises from the aorta at a more obtuse angle.

The results of the process depend, firstly, upon the site of lodgement of the embolus, and, secondly, upon the power of the mesenteric circulation to establish its collaterals which is, in fact, sometimes accomplished. In most cases, however, the result is an infarction of the intestine, and it is interesting to note that, despite their abundant collaterals, the mesenteric arteries behave like "end arteries" in producing this condition of infarction, which is always of the hæmorrhagic type. The explanation of this curious fact may be discussed. It appears that the sudden anæmia produced by the blockage of a branch of the artery sets up a violent spasmodic contraction of the bowel. In this contracted state the method of reestablishing the collateral flow by a dilatation of the vessels in the affected part becomes impossible. Moreover, the

spasmodic condition of the bowel aggravates the anæmia, so that gangrene of the intestine rapidly occurs. The infarction involves the lower part of the ileum, as in the three cases herein reported, and the condition of the infarcted loop is practically the same as that in a strangulated hernia, except that there are no signs on the bowel wall of the effects of the constricting agent. The coil of bowel is dark red, purple or black, is usually very much thickened because of the infiltration of its walls with blood and serum, and is distended by the accumulation of gas and fluid in its interior.

CLINICAL FEATURES.

The condition of mesenteric embolism produces a varied clinical picture. The severity of the symptoms appears to depend upon the site at which the embolus is arrested, and thus upon the amount of mesentery and intestine which is involved. Therefore, the onset, in cases with widespread infarction, is sudden and violent, and is followed rapidly by signs of marked collapse and death quickly follows. In other cases, the onset is less acute, and here it is usually found that only a part of the vascular system of the mesentery has been occluded. Invariably the first symptom is abdominal pain, usually colicky in nature. This may be of sudden onset and acute from the first, or it may gradually increase in severity, but always at some stage in the illness the pain is intense enough to make the patient roll about in an attempt to gain relief. The cause of this intense pain is a matter for conjecture. It is unlikely that it is due to the spasmodic contraction of the affected segment of gut, for in one of the cases reported (Case III), in which the pain was severe right up to the administration of the anæsthetic, the gut was found to be dead. The pain is usually described as colicky in nature, and it may be that it is produced by the violent peristaltic efforts on the part of the proximal gut to overcome the "obstruction" produced by the affected loop. If this view be rejected, then an analogy may be found in the intense pain which often accompanies the occurrence of thrombosis in one of the peripheral arteries, for example, the femoral. It has, therefore, been suggested that the pain of mesenteric embolism may be due to a violent stimulation of the nerves of the mesentery, perhaps by the œdema which always rapidly occurs in that structure.

Shortly after the onset of pain, vomiting occurs and is usually repeated. The case then presents the two salient features of intestinal obstruction and it is with this diagnosis that the patient is prepared for operation, which seems to become all the more urgent as the condition progresses and abdominal distension appears. Bloody stools are present in the minority of cases, but are almost pathognomonic of the condition when associated with the other clinical features. In many of the cases recorded, as in the three under review, abdominal tenderness was an outstanding sign. It was most often in the right iliac fossa, this being explained by the fact that when the infarction of the intestine was only partial, it involved that part of the small intestine usually situated in the right iliac fossa, that is, the terminal ileum.

APPEARANCES AT OPERATION.

When the abdomen is opened, a large quantity of blood-stained fluid escapes. The condition of the intestine varies. Sometimes the surgeon may be confronted by a swollen hæmorrhagic mesentery and a small intestine devitalized throughout its entire length. In other cases, however, there may be only a portion affected, and it is in these cases that correct surgical procedure offers some chance of success. When the condition is limited to a segment of gut and mesentery, the essential point to be decided is whether infarction has occurred or whether the collateral circulation has become established. In arriving at this decision, nothing is to be gained by examining the mesentery and attempting to demonstrate pulsation in the vessels of the affected portion. Attention should be focused on the intestine, for this is the important structure to be considered. If the collateral circulation has become established, the gut will show signs of the recent stress to which it has been subjected. It will be slightly distended, dark in colour, but will contract on stimulation, and pulsation in the arteries near the bowel wall will be readily observed. When infarction has occurred, the gut will be soggy, purple or black, will not respond to stimulation, and its vessels will be pulseless. It is inert and lifeless. The part of the mesentery affected will be greatly thickened from œdema, and widespread splashes of hæmorrhage will be observed.

A striking feature in each of the author's cases was the abrupt demarcation of the affected from the non-affected portions of bowel and mesentery.

TREATMENT.

In cases of mesenteric embolism the surgeon is faced with exactly the same problem as in other cases of intestinal mortification, such as strangulated hernia, strangulation by bands, intussusception, and the like. The surgical principles which guide him in these conditions should determine his actions when he is confronted with the condition of mesenteric embolism. Too often, perhaps, surgeons have been misguided by the traditional attitude of despondency which is held in respect to this condition. Mesenteric embolism is a desperate condition and is usually regarded as fatal, but although the mortality is extremely high, recovery does at times take place. Many cases of recovery are on record in which the diagnosis was made with certainty after abdominal exploration, although no surgical procedures were attempted. These cases of spontaneous recovery are, of course, those in which the collateral circulation had become established. It appears, however, that if infarction has occurred, the only hope for the patient is to resect the affected portion of intestine, while, if the collateral circulation has become established, it is best to rely on the inherent powers of the intestine to recover its function. The first successful case of resection of the infarcted portion of intestine was reported by Elliot[2] in 1895 and, in 1923, Klein[3] stated that about twenty-four further successes were on record. Since then there have doubtless been similar reports.

It is difficult to determine that amount of small intestine which may be safely removed. Brenner[4] resected eighteen feet of small intes-

tine from a strangulated hernia, the patient surviving the operation, but dying of inanition two and a half years after the operation. Permanent recovery has followed after as much as fifteen feet of small bowel has been removed, while in another case death from inanition resulted from the resection of but eight feet. This question is very fully dealt with in Flint's[5] paper on extensive resections of the small intestine.

CASE REPORTS.

CASE I.—A male patient, aged forty-two years, was admitted to hospital complaining of abdominal pain and vomiting of forty hours' duration. Two days previously he had had a bad attack of diarrhœa. The pain was at first moderately severe and situated about the umbilicus. Shortly before admission it increased in severity, became colicky in nature and made him roll about in agony. He vomited shortly after the onset of the pain. There had been no bowel action for forty-eight hours. He had hiccup for fifteen hours prior to admission.

On examination, the patient appeared to be shocked and the pulse, although slow (76), was of poor volume and tension. The urine contained albumin and casts and the blood urea was 40 milligrammes per 100 cubic centimetres of blood. There were 15,000 leucocytes per 100 cubic millimetres. The abdomen was slightly distended, rigid and tender on the right side, with tenderness most marked over McBurney's point. No free fluid was detected in the abdomen. An enema was given without result. Thirty hours later the pulse and general condition were the same and the colicky pains were still present. The abdomen was slightly more distended and free fluid was detected. Hiccup was still present.

Mr. H. R. Dew opened the abdomen through a righ para-umbilical incision. A large quantity of blood-stained fluid was present in the abdominal cavity. The small bowel over an extensive area was dilated, congested and a dark plum colour. The mesentery was examined and "at its root an extensive thrombosis of the vessels supplying several feet (about six) of the small intestine was found. No bowel was actually gangrenous. The abdomen was closed without drainage." For two days the hiccup continued and there was intermittent vomiting. On the third day the patient passed a large fluid motion. On the seventh day the hiccup had ceased, the abdomen was lax and the general condition vastly improved. The patient left hospital on the twentieth day after operation.

CASE II.—A male patient, aged forty-five years, was awakened from his sleep eighteen hours before admission to hospital by severe abdominal pain in the region of the umbilicus. The pain was so severe that he rolled about in bed in attempting to gain relief. It was present up to the time of admission, with spasms of increased intensity. He had vomited five to six times since the onset. The bowels had not been opened since the onset of the pain.

On examination, his temperature was 37·4° C. (99·4° F.), his pulse rate was 90 and his respirations numbered 26. His systolic blood pressure was 160 and his diastolic pressure 100 millimetres of mercury. Examination of heart and lungs revealed no abnormality. The urine was normal. The abdomen moved poorly on respiration. There was slight rigidity on the right side of the abdomen and tenderness in this quadrant, maximum over McBurney's point. No abnormality was detected on rectal examination.

A McBurney incision was made, and on opening the abdomen a fair quantity of thin, slightly blood-stained fluid escaped. The appendix was examined and found to be very bulbous at the tip. It was removed. The mucosa was not inflamed. The McBurney incision was then enlarged by opening the rectus sheath and retracting the muscle medially. A loop of slightly distended, dark, small bowel was then seen, and the corresponding mesentery was œdematous and hæmorrhagic. Further examination showed that about three feet of the ileum and its corresponding mesentery were in a similar condition. Both proximally and distally there was an abrupt transition from normal to abnormal bowel and mesentery. A very careful examination of the transition areas was made, but no signs of a direct injury could be seen. The bowel above was not dilated, and

appeared to be perfectly normal. The affected segment contracted well on stimulation, and its vessels could be seen to be pulsating. Distally the transition to normal bowel and mesentery was seen four inches from the ileo-caecal valve. The ileocolic artery in the mesentery of the terminal part of the ileum was felt to be pulsating. The abdomen was closed without drainage. The next day the abdomen was slightly distended and an enema and a subcutaneous injection of one cubic centimetre of pituitrin were given. A large bowel action resulted and a considerable quantity of flatus was passed. The patient almost immediately experienced great relief.

On the fourth day after operation violent abdominal pain, followed by vomiting, occurred. The general condition was good and the pulse rate 84. The abdomen was still slightly distended. The pain persisted, and the next day the abdomen was more distended. It was obvious that the patient had an intestinal obstruction and it was decided to operate forthwith.

Under a combination of local and gas anæsthesia, a small right lower paramedian incision was made. There was a fair amount of slightly blood-stained free fluid in the abdomen. The affected segment of gut which had been observed at the first operation, was examined and appeared perfectly normal, except that at intervals a vigorous spasm was seen to occur. The corresponding mesentery was less œdematous than before, and the hæmorrhages showed signs of absorption. The whole process appeared to be rapidly resolving. The intestine above the affected loop was distended, but not greatly so. An ileostomy above the "affected loop" was performed by suturing a loop of bowel to the parietal peritoneum, stabbing it with a tenotome and stitching in a number 9 rubber catheter. The patient's general condition appeared to be unaffected by the operation. During the next three days the ileostomy drained only moderately well, the abdomen was slightly less distended, but the patient continued to have attacks of severe abdominal pain. There was no vomiting. The general condition was slightly worse, the pulse rate remaining about 100. Enemata produced moderately good fluid results and some flatus was passed.

It was quite apparent that the patient's condition was not due to a paralytic ileus. The chief complaint was intermittent, severe abdominal pain without vomiting, and, in addition, the continuous discomfort of a distended abdomen. As severe pain is not a feature of paralytic ileus, but suggests that the intestine is active, even hyperactive, it was thought that the condition of the patient was to be explained by supposing that the loop of ileum which had been temporarily affected by the embolus, although appearing normal in appearance at the second operation, had not yet recovered its balance, but had remained in a state of spasm. The appearances observed at the second operation where vigorous spasmodic contractions were seen to occur in the "affected loop", lent some support to this opinion. The condition was, therefore, treated as one of "enterospasm" and large doses of morphine were administered, and as the patient's general condition showed signs of deteriorating, two intravenous infusions of glucose and saline solution were given. After twenty-four hours, a marked improvement was noticed. The attacks of abdominal pain became less severe and soon ceased altogether. The ileostomy drained freely, large quantities of flatus were passed *per rectum* with fæcal matter in addition, and the abdomen gradually became soft and flat. A week after the second operation, recovery appeared to be certain. The ileostomy tube became loose and was removed on the sixth day.

The ileostomy wound continued to discharge freely and, despite frequent dressings and applications of various ointments, and other substances, a severe excoriation of the abdominal wall occurred. The bowel continued to discharge its contents, but as the margins of the wound were wide apart and semi-digested, one was loath to attempt closure of the bowel by operation. The patient was, therefore, starved for three days and, during this time, given saline solution and glucose *per rectum*. Then a small non-residual diet was allowed for a few days and the starvation period was repeated. The wound gradually healed in and, at the present time, two months after admission to hospital, the wound is of "pin hole" size and discharges very slightly at intervals. The patient's general

condition for some weeks has been perfectly satisfactory, and he has been allowed out of bed each day.

CASE III.—A male patient, aged fifty-two years, had had no previous illnesses. He was admitted to hospital complaining of abdominal pain for eleven hours. At midnight he had been awakened with acute colicky pain about the umbilicus. The pain was continuous with spasms of intensification right up to his admission to hospital. Vomiting occurred eight hours after the onset and this was twice repeated. For the few hours just prior to admission, the pain had shifted to the right iliac fossa. There had been no vomiting for six hours.

On examination, the patient's general condition was good. His temperature was 37·4° C. (99·4° F.), his pulse rate was 84 and his respirations numbered 20. He was apparently having severe pain, for at times he would draw his legs up and groan. His systolic blood pressure was 160 and his diastolic pressure 100 millimetres of mercury. Examination of heart and lungs revealed no abnormality. The urine contained sugar "+++". The abdomen was slightly distended. There was marked rigidity of the right side, most marked in the lower part. Tenderness was elicited over the right lower abdomen with its maximum over McBurney's point. Rectal examination revealed nothing abnormal.

At operation, in view of the marked local signs, a small McBurney incision was made. Large quantities of grossly blood-stained fluid escaped on opening the peritoneal cavity and the small intestine in right iliac fossa was seen to be almost black. A right lower paramedian incision was then made and the rectus muscle retracted outwards. The small intestine in the right iliac fossa was dark purple, soggy and lifeless. No contractions could be induced and there was no arterial pulsation. The corresponding portion of the mesentery was thick with œdema and hæmorrhages. There was a sharp line of demarcation between the dead bowel and the normal bowel, below which was contracted and that above which was slightly dilated. The whole of the affected segment of bowel was brought out of the abdomen and section of the small intestine made six inches above and below the limits of the infarction. A resection of the corresponding mesentery was effected, all the œdematous hæmorrhagic portion being removed. Both bowel ends were closed and a side-to-side anastomosis performed, four layers of sutures being used, and the gap in the mesentery restored. The wound was closed in layers which interrupted sutures and a drainage tube led out of the abdomen through the rectus muscle in the lower part of the wound. The McBurney incision was then closed. During the operation, which occupied forty-two minutes, a pint of glucose and saline solution with thirty units of insulin was administered intravenously.

The portion of intestine resected measured nine feet eight inches. Its lumen contained dark tarry fluid. No attempt was made during the operation to examine the mesenteric vessels for the thrombus.

The patient's condition at the end of the operation was fairly good. Submammary saline and glucose infusions were commenced and during the next twenty-four hours six pints of fluid were introduced. The general condition remained extremely good, but for three days the abdomen was distended. An enema then produced a good result with the passage of quantities of flatus and the patient felt greatly relieved. For the next three days there was diarrhœa, which was controlled with doses of bismuth and opium. On the fourteenth day after operation the abdomen was flaccid and the bowel action almost normal. The patient was eating well, looked well and felt well. On the twentieth day after operation, the patient was allowed out of bed. His bowel actions were normal and there were no signs of nutritional disturbance. The patient was discharged from hospital on the twenty-eighth day. Since then he has gained in weight, his bowel actions are normal, and he appears to be perfectly well.

REFERENCES.

(1) Trotter: "Embolism and Thrombosis of the Mesenteric Vessels", 1913.
(2) Elliot: *Annals of Surgery*, 1895, Volume XXI, page 9.
(3) Klein: *Surgery, Gynecology and Obstetrics*, Volume XXXIII, page 401.
(4) Brenner: Quoted by Flint, *loco citato*.
(5) Flint: *Bulletin of the Johns Hopkins Hospital*, 1912, page 127.

THE PRESENT POSITION OF SPINAL ANALGESIA.

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The value of spinal analgesia has again become a matter for debate. The method of inducing surgical analgesia by the direct action of drugs upon the spinal nerve roots and cord was first introduced by Bier in 1896. Bier employed cocaine, and its use was followed by grave ill effects in such a high percentage of cases that the method fell into disrepute. Out of 4,679 cases of spinal (cocaine) analgesia reported up to 1902, fifty-eight were accompanied or followed by serious disturbances, including paralysis of the lower extremities, paralysis of the rectal and vesical sphincters, severe collapse and symptoms of meningeal irritation. In twelve cases death followed closely on the injection of cocaine, and was regarded as due to its use.

The discovery of the less toxic "Stovaine" by Fourneau in 1903 and its introduction into surgical practice by Reclus revived this method of surgical analgesia, but after an experience derived from its employment in a great number and a great variety of cases, many surgeons discountenanced its use because of the inherent dangers accompanying or following its administration.

The introduction of new and less toxic drugs and improvements in the method of administration have lessened greatly the ill effects which previously accompanied and followed the employment of spinal analgesia. Once more it has become a matter for consideration whether spinal analgesia is sufficiently devoid of risk to warrant its employment. To justify its use, it should offer some advantage and, above all, the risks and ill effects consequent upon its administration should be, at any rate, not greater than those associated with the least dangerous general anæsthetic available for use in any case in question.

Now spinal analgesia does offer distinct advantages in that it produces an extraordinary muscular relaxation with small respiratory excursions, and thus furnishes a set of conditions of great advantage in abdominal and pelvic operations; after long operations, moreover, the patient is not taxed with the elimination of ether or chloroform, nor with their effect upon the respiratory or circulatory system in cases where these drugs were the alternative to its use.

Against these advantages must be considered the risks of certain ill effects which have been attributed to the toxic nature of the drug employed, the inability to limit its analgesic effect to the field of operation and the difficulty of controlling the dose according to individual

requirements. Though improvements in technique have reduced or eliminated many of the ill effects which used to be attributed to the toxic nature of the drug, current literature still abounds with proof that the intraspinal injection of "Novocain", "Spinocaine", "Gravocaine", "Durocaine" and the newer "Percaine" may be followed by grave ill effects. Experience has shown that whilst ephedrin may alleviate the fall of blood pressure, it cannot be relied upon to prevent its occurrence after the employment of a spinal analgesic. This fact by itself calls for caution in the use of spinal analgesia in conditions accompanied by cardio-vascular disease.

The means employed to limit the analgesic effect to the field of operation in the method described by Kirschner are complicated and cumbersome to carry out, whilst both his method and that of Howard Jones depend upon the quality of a drug, "Percaine", which has proved itself toxic as a local analgesic and so has received the condemnation of Finsterer and others. The use of "Percaine" as a spinal analgesic calls for caution.

Individual differences in response to a spinal analgesic are well known and call for an ability to grade the dose according to individual requirements. The method so far evolved is complicated. It is difficult to reduce an overdose the result of ignorance, accident or bad judgement.

The employment of spinal analgesia should be determined in every case by the most careful consideration on the part of the anæsthetist and the surgeon, of the risks and the advantages of the various methods of anæsthesia and analgesia available. The indiscriminate use of spinal analgesia calls for the severest condemnation.

Surgical Technique.

THE TECHNIQUE OF THE INTRAVENOUS ADMINISTRATION OF BLOOD AND PHYSIOLOGICAL SOLUTIONS.

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AND
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Our purpose in presenting this article is to deal exclusively with the technique of blood transfusion and with the intravenous injection of physiological solutions, summarizing the well-known principles and attempting to add thereto a few points which we have ourselves found of value. No attempt is made to deal with the indications for, or the underlying theory of, these procedures; but the actual steps lying before the surgeon faced with the giving of such treatment will be traced in order. Any consideration of the complications which may arise has been omitted, but it is reasonable to state that the frequency of these will be very low if a good technique is closely followed.

Blood Typing.

The well-known work of Moss and others upon blood groups and the typing of blood need not be entered into here. In practice, it is desirable in every instance to ascertain the type of both the patient and the intended donor by testing against known group sera. Sera of Groups II and III are required for this process. It is of interest to note that these sera keep satisfactorily for long periods, but it is probably not wise to rely upon them after three months. Putrefactive processes appear to have little effect upon their group properties, so that rigid asepsis is not necessary in handling them. A drop of each of these sera is placed upon a clean glass slide or, preferably, a white tile (see Figure I). A few minims of the blood to be examined are drawn into a few minims of 2% sodium citrate solution and well shaken. To each drop of serum a drop of this suspension is added, and thorough mixing is effected. The drops are then watched for characteristic appearances of agglutination, which are best seen if the surface used is slowly inclined, first in one direction, then in another, so that flowing movements occur in the drops. The first appearance is that of fine, almost microscopic, granularity, suggesting fine sand washing over the surface. This rapidly becomes coarser until ultimately there is the

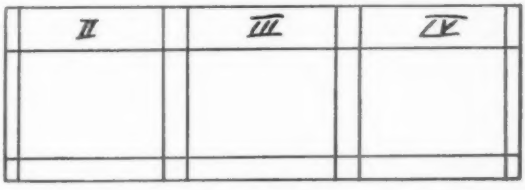

Figure I. Glass slide, ruled into compartments with glass pencil, ready for typing.

appearance of gross clumps of red corpuscles surrounded by clear serum. This whole cycle usually takes place in from two to five minutes, and it is safe to say that where no change is observed in five minutes true agglutination will not occur. The accompanying schema (Figure II) shows both the actual appearances of the agglutinated and non-agglutinated drops and also the reactions characteristic of blood of the four groups. This examination having been carried out with regard to both recipient and donor, it is desirable further to cross-type the blood of the two. This is a very simple procedure, so much so that there seems little reason why it should ever be omitted. A drop of citrate suspension of the blood of each is mixed upon the slide or tile and observed for the changes already described.

Attention has been drawn to the effect of blood diseases by a number of writers. The practical conclusion to be drawn from their observations would appear to be the absolute necessity of direct typing in such cases, as anomalous reactions may occur which are not apparent in simple typing, but may have grave clinical significance.

It is important to note that a transfusion may itself influence the agglutination reactions of the recipient's blood, so that it is imperative to retype the patient before proceeding to each successive transfusion, even if the same donor be used. Further, it is essential that a direct typing be not omitted, even though the same donor be employed, and that donor and recipient be of the same group.

Sepsis may produce peculiar anomalies of type. In a recent case, a patient of Type II was suffering from a pyonephrosis with perinephric abscess, and post-operative transfusion was deemed desirable. The blood of three successive donors of the same type, and of one of Group IV, was cross-typed against this patient's blood, and all specimens were agglutinated. Previous cases of this kind have come to our notice. It would appear that transfusion must be withheld in them unless it is of the most vital urgency, and in two such cases where transfusion has been carried out, although febrile and vasomotor reactions were severe, the outcome was satisfactory and there was no obvious excretion of hæmoglobin.

With regard to the transfusing of blood to infants, it is commonly stated that typing is of no clinical importance. This cannot be upheld, and typing should be carried out in every case, irrespective of age or circumstance.

Taking the Blood.

In the taking of blood it is desirable that as little disfigurement as possible be caused to the donor, and for this reason the method of taking blood through a needle is urged whenever possible in preference to open venesection. With adequate attention to technique it is entirely reliable whenever veins of reasonable size can be seen or felt. The vein usually selected for the purpose is the median basilic vein of the elbow, though it occasionally happens that one of the other veins in the region is more suitable. The patient is placed upon a bed, propped up into a half-sitting posture by means of pillows, and well to the side upon which the operation is to be carried out. A small table is provided as a support for the arm. A tourniquet is applied to the upper part of the arm to bring the veins into prominence and to permit easy inspection. An ordinary rubber tube may be used, in which case it should be applied firmly, but with such tension that the radial pulse remains strong. Alternatively, a sphygmomanometer may be used, in which case it is set at the diastolic pressure, or a little lower. Should the veins not be prominent, considerable improvement may be effected by immersing the arm in very warm water for a few minutes. A suitable vein having been selected, the skin is cleaned by swabbing with any of the usual antiseptics. Iodine, mercurochrome, flavine and picric acid should be avoided, as their deep colour tends to obscure the veins. The operator's hands and the skin are now rinsed with citrate solution to dilute any superfluous antiseptic which might act as a blood coagulant. An adequate amount of sodium citrate solution, which has been warmed to blood heat, is placed in the receiving vessel, which stands in a jacketing vessel of water at about 40·5° C. (105° F.). Authorities vary considerably in regard to the amount and concentration of the citrate solution employed, between Oswald Robertson's original 160 cubic centimetres (five and a half fluid ounces)

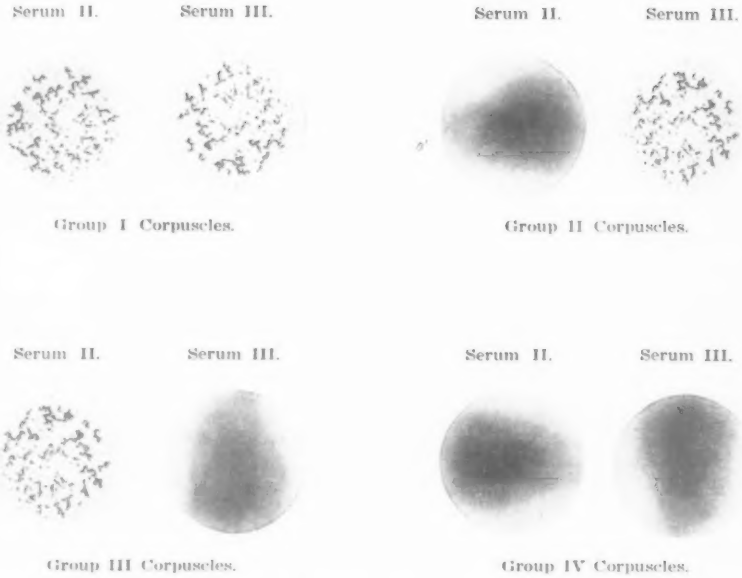

FIGURE II. Showing macroscopic appearances seen in typing blood by the indirect method. [From *The Medical Journal of Australia.*

of 3·8% solution for 750 cubic centimetres (twenty-six and a half fluid ounces) of blood and the commonly employed 100 cubic centimetres (three and a half fluid ounces) of 2% solution for 900 cubic centimetres (thirty-one and a half fluid ounces) of blood. As to the receiving vessel, any receptacle having a wide mouth and susceptible of satisfactory sterilization may be used, and it is a common practice to employ an imperial glass measure standing in a bowl of warm water. Such a simple arrangement is, however, liable to many accidents, and to reduce the number of these and to facilitate the collection of the blood directly from the spout of the needle, one of us (C.W.R.) has devised a simple jacketed metal vessel of suitable proportions (see Figure III). The skin may now be anæsthetized. The most satisfactory method is to raise an intradermal wheal by the injection of a 2% solution of "Ethocaine" or "Novocain", about 2·5 centimetres (one inch) proximal to the point at which it is proposed to enter the vein, and through this to infiltrate the skin in the shape of a broad arrowhead open distally. This will be found to give adequate anæsthesia in the small included area. A tourniquet is now applied, and the donor is directed to

FIGURE III. Kettle for use in transfusion, showing the long collecting spout, water-jacket and comfortable handles.

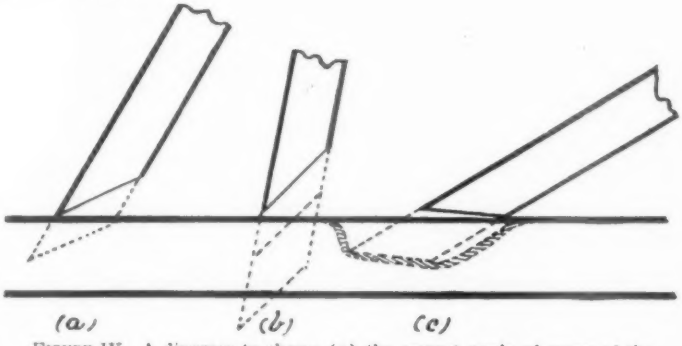

FIGURE IV. A diagram to show: (*a*) the correct angle of entry of the needle into the vein; (*b*) too obtuse an angle, with danger of transfixion of the vessel; and (*c*) too acute an angle, with failure to penetrate the vessel wall.

clench and unclench the hand, slowly and firmly, a few times. This should bring the vein clearly into view or, in the case of a deep vein, should make it readily palpable. With a sharp tenotome a puncture sufficiently large only to accommodate the needle to be used, is made directly over the vein, passing freely through the skin. The needle is now taken from the citrate solution in which it has been kept, and is inserted pointing distally through the puncture and into the wall of the vein. It is essential to pay strict attention to the angle between the needle and the skin surface, and to see that the bevel opens towards the skin, the effects of any error in these matters being shown in Figure IV. If the vessel used for the collection of the blood is not of suitable shape, some assistance may be derived from the use of a small length of rubber tubing attached to the needle. The needle employed should be of wide bore without break in its inner surface, and should have an obtuse but very sharp bevel. It should be short, and bright inside and out. Two practical sizes are shown in Figure V. As success depends largely upon the fitness of the needle, it is most desirable that suitable ones be set aside for this purpose alone, so that they may always be in perfect order. As the blood spouts into the citrate solution, gentle stirring is carried on by means of a glass rod, the lower end of which is shielded by a short length of rubber tubing. When the required amount has been collected, the tourniquet is removed, and the needle is withdrawn by the right hand as the left instantly covers the puncture with a pressure-pad of cotton wool. Hæmostasis results after pressure has been maintained for a minute or two. No suture is necessary, but a firm dressing should be retained for a few hours. If blood is not readily obtained by this method, it is better to perform open venesection and cannulize the vein, as described later, than to persevere with the needle.

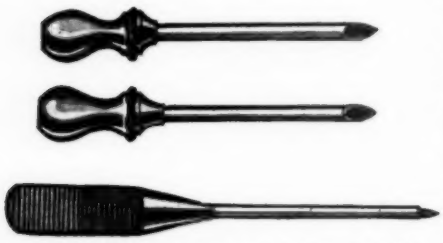

FIGURE V. Above, two useful sizes of needle for taking blood. Below, a trocar needle for use in small veins.

Giving Blood to Adults.

It is not usually desirable to give blood through a needle puncture, open can-

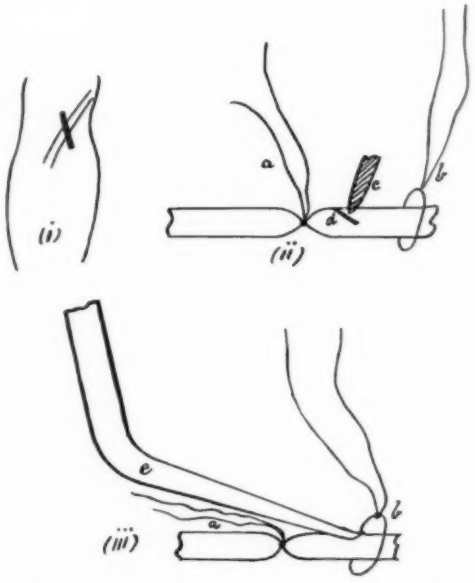

FIGURE VI. (i) Showing the relation of the incision to the vein. (ii) Showing (*a*) and (*b*), the distal and proximal ties; (*c*) the beak of a mosquito forceps holding the vein wall; (*d*) the oblique incision, made with fine scissors. (iii) Showing the cannula (*e*) entering the vein.

nulization of the vein being preferable. A tourniquet is not often necessary in this procedure, but it may be useful to apply one for a few moments to aid in the localization of the vein. This purpose can usually be filled by manual constriction of the arm. Should the patient show any tendency to restlessness, a simple dorsal splint, wide and adequately padded, may be loosely bandaged to the arm. The addition of a minim or two of adrenaline solution to the anæsthetic is useful, as it practically banishes blood from the incision. The line of incision should be placed so as to cross the vein, making with it an angle of about 30°, and should be 12·5 to 18·0 millimetres (half to three-quarters of an inch) long. The purpose of this is to insure that the vein be not lost in one wall of the incision, and further to confer free mobility in any direction. The incision is carried through the true skin into the loose fatty tissue, and thereafter blunt dissection is used, duly bringing the vein into sight. A catgut ligature is passed under the vein by an aneurysm needle, artery forceps or dissecting forceps, and is cut to provide proximal and distal ligatures. The distal one is tied and the ends are left long and seized with a pair of artery forceps. A single tie is loosely laid in the proximal ligature. The funnel, tube and cannula are now filled with warm normal saline solution and held by the assistant, who clamps the rubber tube when all the air has been expelled. The vein is then lifted out of the incision by traction upon the distal ligature and with fine scissors it is snipped half-way through at an angle of 45° to its length. The tip of the cannula is inserted under the tongue so formed, just so far that its taper fits snugly into the hole in the vessel, the solution being meanwhile allowed to drip from it. The saline solution should now flow freely in. Failure to do so is possibly due to angulation of the cannula, the end of which may be jammed against the wall of the vein, or to the fact that the cannula lies outside the lumen between the coats of the vessel, a mishap which is easily avoided, as in adults the lumen is clearly visible after an adequate cut has been made. A free flow of saline solution having been obtained, the introduction of blood follows. During the inflow of the first few cubic centimetres of blood, close watch is kept for respiratory distress, pallor or complaint of pain in the loins or chest, as these will be the earliest signs of incompatibility should any accident have led to its occurrence. The last portion of the blood may be carried into the vein by the use of another funnel full of saline solution. The tie in the upper ligature is now drawn tight over the cannula as this is withdrawn and ligation is completed. The skin is closed with one or two horsehair sutures and a dressing is applied.

The Suction Bottle Method.

The use of a suction bottle has several advantages to compensate for its added complexity. A smaller needle may be used, and thus the method is useful where only small veins are available. It reduces the risk of clot formation in the needle by reason of the more rapid flow, and should tend to minimize contamination. Any fairly wide-mouth bottle of about 900 cubic centimetres (thirty fluid ounces) capacity and of transparent glass is suitable (see Figure VII). It is usefully graduated by means of a strip of adhesive plaster marked off in cubic centimetres or fluid ounces. To a suitable india-rubber stopper two right-angled glass tubes are fitted, extending about 2·5 centimetres (one inch) into the bottle. One is to convey the inflowing blood and is left short so that the stream may be observed throughout. This is found more satisfactory than the use of a window alone, as the latter is of little use once it is soiled with blood. The second is for the attachment of a reversed Higginson's syringe, which appliance, it is interesting to note, was originally devised for use in the transfusion of blood. To the first tube there are attached about 22·5 centimetres (nine inches) of relatively new, clean, stout, rubber pressure tubing, into the end of which is fitted a needle, either directly or by means of a metal connexion. The apparatus being thus connected together, the bottle is placed in a jacketing vessel of adequate depth to warm the whole of it, leaving only enough of the neck exposed so that the flow of blood may be observed. If the jacket does not reach high enough, fogging of the bottle is apt to occur by condensation. The graduations should be so placed as to be visible to the operator. By operating the Higginson's syringe almost the whole amount of citrate solution to be used is drawn through

the needle into the bottle, and is allowed to stand in the jacket until it is warm. When all is ready, and just before inserting the needle, the whole system is again moistened by drawing in the last few drachms of citrate solution, of which a further supply is kept at hand for similar use should any stoppage be necessary. The needle is now removed from the rubber tube and inserted into the vein by the technique already described. When the blood gushes in a full and satisfactory stream, the tube is again carefully connected to the needle and the Higginson's syringe is operated. Owing to the intrinsic limitations of this appliance too much suction, causing collapse of the vein, is scarcely possible, and, further, it is advisable to make use of gravity to assist the flow by seeing that the bottle remains lower than the arm. It is important that the system be free of leaks, which may lead to great frothing of the blood. Mixing is accomplished by gentle oscillation of the bottle. At the conclusion, the tourniquet having been removed, the needle withdrawn and a pad applied as before, a drachm or two of citrate solution is again drawn through to flush out the system. The giving of blood may be carried out either by the simple gravity method or by the following technique, which is specially useful where, as is often the case in children, greater positive pressure is required. The Higginson's syringe is now removed, the stopper is withdrawn from the bottle, and there is attached to the inner end of one of the glass tubes a length of stout rubber tubing, a little more than sufficient to reach to the bottom of the bottle. The stopper is replaced.

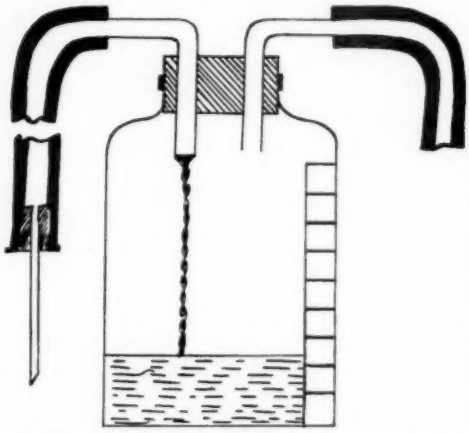

FIGURE VII. A bottle set up for taking blood by the suction method.

The needle is removed and a Kob (or Jubé) syringe, the barrel of which has been lubricated with glycerine, is attached to the needle or cannula to be used for the infusion. The vein having been exposed, the needle or cannula is inserted after the whole system has been filled with blood to the exclusion of air, a simple matter if the syringe be judiciously manipulated so that the air may rise to the outlet. The Kob syringe is clearly demonstrated in Figure VIII. It is now available with only two tubulures, in which form it has been prepared for us by Messrs. Felton, Grimwade, of Melbourne.

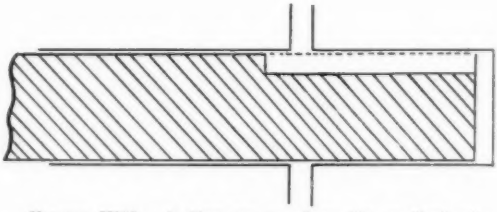

FIGURE VIII. A diagram to show the method of working of the Kob syringe, with it on the grooved, rotating piston principle used by Jubé.

Rate of Administration.

In every case of the injection of fluids into veins, the most careful control of the rate of flow is essential. The supreme consideration is the patient's response, but experience has shown that the rate of one pint in twenty to thirty minutes

is satisfactory in the treatment of most adult patients, though for sick patients an even slower rate may be necessary. For infants and children the full dosage, whatever its actual volume, should not be given in less than this time. The first sign of overtaxing of the vascular system is usually a sense of substernal tightness, respiratory distress or epigastric discomfort. Should any of these occur, the administration is stopped for ten minutes or so, and resumed only with extreme caution.

Giving Blood to Infants.

In the case of infants and young children up to about two years of age, the most favourable site for the injection of blood is the great saphenous vein at its origin opposite the medial malleolus from the medial marginal vein of the foot. Splinting is essential, some simple well-padded form of back splint being used, and the other leg being attached to the table by a clove hitch. A pillow under the opposite buttock is helpful, as it reduces the necessary degree of external rotation of the leg. The skin is prepared with spirit or the A.C.M. solution (which should be rapidly swabbed off) and "Novocain" with adrenaline is injected along the line of the incision, which should be eighteen millimetres (three-quarters of an inch) long and made transversely to the long axis of the leg with its central point slightly anterior to the middle of the medial malleolus, to expose the vein as it runs over the anterior third of the malleolus. This vein is very constant in position and, though seldom visible, it is often detectable by very careful palpation. The vein is exposed by this transverse incision if its position is at all doubtful, but if it can definitely be localized, the usual incision at 30° may be used. Some surprise may be experienced at the depth at which the vein is encountered, and failure to expose it is often due to the operator mistaking for it a fine superficial venous plexus, the great saphenous vein itself lying deep to this. It is fortunately large and, once revealed, it usually offers no obstacle to the insertion of a needle, which is effected by the same technique as we have recommended for the cannulization of adult veins, except that it is useful first to establish the patency of the lumen by the use of a fine probe. It is necessary, moreover, to tie in the needle owing to the absence of a taper. A trocar needle (see Figure V) is desirable, but any large hypodermic type may well be used so long as it is not too sharp. The injection of the fluid may be carried out by means of the Kob syringe, or if this is not available, by the repeated use of record syringes with india-rubber connexions to avoid any movement of the needle. Small frequent drinks will be found useful in pacifying the child during the operation, and the use of a mastic dressing is to be recommended.

Amount of Blood to be Given.

As regards the amount of blood to be given in the adult, no discussion is necessary, because this is very variable according to the indications, and the fundamental principles of decision are well known. In children, as a working rule, 10 cubic centimetres per pound body weight may be adopted, though it is often permissible to give more in cases of gross blood loss. Children of ten or twelve years approximate rather to the adult in this matter, and children of twelve having suffered severe hæmorrhage may well be given one pint of blood.

Preparation of Solutions.

The first essential to success in the use of intravenous physiological solutions is that the preparations themselves be above suspicion. The results of considerable practical and experimental experience in this matter have been summarized in a recent article by Cooper and Haldane.[1] Their conclusions are, briefly, that fresh doubly glass-distilled water should be used, that chemically pure substances (particularly glucose, in the case of which the U.S.P.X. standard is recommended) of very high standard must be insisted upon, that open boiling on an electric heater is the most satisfactory method of sterilization, that solutions should be buffered after sterilization by the addition of sterile di-sodium-hydrogen-phosphate solution to give a pH value of 7, and that solutions should be freshly prepared and, if stored at all, should be checked at frequent intervals and kept at a uniform low temperature in the dark.

Administration of Solutions.

In the adult, saline and glucose solutions can usually be given through a needle either by means of the simple gravity funnel or with the aid of the Kaufman syringe, to be described later. Should these methods not be feasible in any case, the technique of exposure and cannulization of a vein already described is applicable. In infants and children the same technique is used as for giving blood. In babies in whom the anterior fontanelle is as yet open, usually up to about fourteen months, the median longitudinal sinus offers an alternative route. We are, however, strongly opposed to the giving of blood by this route, as the accidental perforation of the deep wall of the sinus has led to death, *post mortem* examination showing an extensive collection of blood in the subdural space. The area around the fontanelle is shaven and cleaned with spirit or the A.C.M. solution. The child is held supine, the head being controlled by an assistant, the arms and legs are immobilized by pinning a sheet about the child, who is laid across the bed, the head well to the operator's side (see Figure IX). The operator must be

FIGURE IX. Showing the introduction of glucose-saline solution into the superior longitudinal sinus by means of the Kaufman syringe.
[From *The Medical Journal of Australia.*

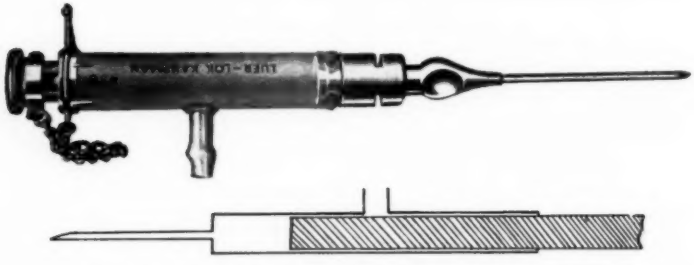

FIGURE X. The Kaufman syringe with a diagram to show the mode of working. It serves as exploring syringe, window and valve, and avoids any risk of moving the needle once it has entered the vessel.

seated, and matters should be so arranged that any position he may have to adopt will be comfortable. A great convenience is the use of the Kaufman syringe (see Figure X). This instrument is similar in size and pattern to the usual hypodermic syringe, but has a side-tube midway along the barrel, and a ground

glass plunger with a restraining chain to prevent its being withdrawn too far. It is also fitted with the Luer-Lok device for attaching the needle. A needle of about size six or eight is connected to the syringe, a rubber tube and glass funnel to the side-tube, and the whole is filled with saline solution to the exclusion of air. The needle is inclined at about 35° to the scalp, pointing towards the occiput (as the sinus attains a greater width as it is traced dorsally) at a point about six millimetres (a quarter of an inch) anterior to the posterior limit of the fontanelle. It is inserted with the greatest caution, the median plane being strictly adhered to, to a depth of a few millimetres, a negative pressure being maintained in the syringe barrel by the traction on the plunger. As soon as the free entry of blood is seen, advancement ceases, the plunger is drawn back—and this is a matter of the greatest ease if the needle is truly in the sinus—and the infusion commences. Frequent small drinks are useful in pacifying the infant during the process, and a simple preliminary sedative, such as chloral hydrate, is often called for, as crying greatly increases the intravenous pressure. Usually a head of 30 to 45 centimetres (twelve to eighteen inches) pressure suffices to give a satisfactory flow. Should a stoppage occur, a slow return and withdrawal of the plunger will verify the position of the needle. When the necessary amount of saline solution has been introduced, the needle is withdrawn and a pressure-pad of cotton wool is applied and held firmly in place for one or two minutes to prevent the bleeding which would otherwise occur. A dressing of collodion and cotton wool is advisable. We have seen this procedure carried out daily for seven days without any untoward event, and in some hundreds of cases we have as yet seen no fatality attributable to this method of administering saline and glucose solutions.

Reference.

[1] E. L. Cooper and A. J. B. Haldane: "A Note on the Preparation of Intravenous Solutions", *The Medical Journal of Australia*, May 21, 1932, page 736.

Case Reports.

A CASE OF HYDATID OF THE KIDNEY.

By Victor Hurley,
Surgeon to In-Patients, Melbourne Hospital.

W.G.H., a male, aged fifty-two years, was seen on April 6, 1932, and gave a history that since the age of eighteen years he had been subject to attacks of pain in the region of the left kidney, which occurred once or twice a year and lasted usually for two or three days. In these attacks there was a feeling of fullness in the left loin, followed by colicky pains which were typically renal in character, and by the passage of shreddy material in the urine which the patient described as resembling "grape skins". Scalding and frequency of micturition were also present. He did not seek medical advice for these attacks until 1925, when Dr. A. P. Derham saw him in an attack of typical left renal colic, and on examining the urine microscopically found laminated hydatid membrane, hooklets and scolices. There were also a few leucocytes in each low power field. One year previously, Dr. Derham had seen him for anginal symptoms with cyanosis. He found that there was a systolic murmur audible at all areas and a diastolic murmur at the aortic area. The systolic blood pressure was 125 and the diastolic pressure 85 millimetres of mercury, and there was a history of rheumatic fever some fifteen years previously.

When the diagnosis of hydatid was made, he was seen by a consulting physician, who advised against operation because of the cardiac condition. This, however, gradually improved under treatment, and he was able to do light work as a cabinet-maker, though he had several periods of cardiac discomfort with palpitation, pain not typically anginal, and tachycardia, in which the pulse was noted to be 150 per minute.

In the succeeding years the attacks of renal colic continued to occur with increasing frequency and severity, and the question of surgical interference was again raised. Accordingly, he was seen by a cardiologist in November, 1931, who reported a fair cardiac efficiency and normal electrocardiograph tracings. In view of these findings, after his next attack of renal colic he was referred for surgical opinion on April 6, 1932.

On examination, he was noted to be of spare build, looked more than his years, and was slightly cyanosed. The apex beat was in the fifth left intercostal space 12·5 centimetres (five inches) from the mid-line, and there was some dulness on percussion to the right of the sternum. The heart sounds were regular and a systolic bruit was audible at all areas. The second sound at the aortic area was loud and sharp. The lungs were normal on examination, and X ray films of the chest showed a moderate enlargement of the heart, but did not disclose any evidence of intrathoracic hydatid. There was no evidence of enlargement of the liver either on clinical or X ray examination, nor was there any evidence of hydatid cysts other than renal elsewhere in the body. The systolic blood pressure was 110 and the diastolic pressure 55 millimetres of mercury. There was tenderness on deep percussion over the left kidney posteriorly and the lower pole of this kidney was just palpable on deep inspiration. Examination of the urine disclosed a specific gravity of 1·010, a trace of albumin, but no sugar. "Grape skins" were present, and on microscopic examination laminated hydatid membrane,

scolices and hooklets were found. Numerous pus cells and *débris* were also present. The Casoni gave a strongly positive ("P+++") reaction, but the complement deviation test gave no reaction both by warm and ice-box methods.

X ray examination of the urinary tract revealed a rounded shadow 6·25 centimetres (two and a half inches) in diameter in the region of the upper pole of the left kidney with irregular dense calcification in what was evidently a hydatid cyst. This is clearly shown on the film (see Figure I).

Cystoscopic examination on April 19, 1932, showed a normal appearance of the bladder mucous membrane. Both ureteric orifices were clearly seen, the right was normal in appearance with a clear urinary efflux, the left was larger and more rounded in outline and was displaced somewhat to the left and upwards. The urinary efflux from the left ureter was turbid. Five cubic centimetres of indigo carmine were injected intravenously, and the dye appeared from the right ureter

FIGURE I.

in three and a half minutes, with a deep colour in five minutes. No dye was seen from the left ureter at the end of ten minutes, and this ureter was then catheterized; eighteen cubic centimetres of 15% sodium iodide solution were injected and a pyelogram was taken. It was noted that indigo carmine appeared at the end of the catheter in fifteen minutes, and was of deep colour in another two or three minutes, so that a certain degree of efficiency was still present in the left kidney.

The pyelogram (see Figure II) showed a large circular area of translucency, evidently a cyst at the upper pole of the left kidney which was surrounded by an opaque wall, partly due to the calcification of the cyst and partly outlined by the iodide solution. The cyst communicated with the upper calyx of the kidney through which the iodide had entered the cyst. The middle and lower calyces were comparatively normal. The renal pelvis was dilated, while the ureter was grossly dilated for its full length.

A flare up of the infection of the urinary tract followed the cystoscopic examination and the temperature was raised for ten to fourteen days, with pain over the left kidney and frequent passage of "grape skins". There was also an increase in the pyuria, and a small amount of hæmaturia occurred on two or three occasions. This subsided under treatment, and he was advised to defer operation for a month.

Left Right

FIGURE II.

He was readmitted to hospital on May 17, 1932, and his condition was much the same as when first seen. There were occasional "grape skins" in the urine and a moderate degree of pyuria.

Operation was carried out on May 20, 1932, when the left kidney was exposed by the usual lumbar route. As the cyst was in the region of the upper pole of the kidney, and probably densely adherent owing to the lengthy history and infection, the twelfth rib was removed. The perinephric tissues were dense and of almost cartilaginous hardness. A cyst larger than a cricket ball, with thick calcified walls, was opened and found to contain hundreds of small daughter

cysts and foul urinous-smelling fluid. Owing to the adhesion of the cyst wall to the perinephric tissues and the marked calcification of its walls, there was no tendency for it to collapse after its contents had been completely evacuated. The interior of the cyst was swabbed with 10% formalin solution. The opening of communication with the upper calyx could not be demonstrated. Complete removal of the calcified cyst was obviously not possible, and it was thought that internal drainage by way of the communication with the rental pelvis and ureter would be sufficient. External drainage would have been likely to be followed by further infection from without and also by a permanent urinary fistula. Accordingly the opening in the cyst was closed by suture, and a small drain of rubber tissue inserted down to this point. The wound was closed. Convalescence proceeded normally, and the patient was discharged to the convalescent hospital three weeks later with the wound well healed except for a small urinary fistula at the lower end of the wound. This soon healed, and when he reported back at hospital a month later, his general condition was much improved, and his wound was quite dry and well healed. He expressed himself as feeling better than he had for years, and he has since been able to do light work.

Comment.

Hydatid cysts of the kidney are comparatively rare; most observers estimate that about 2% of all hydatid cysts occur in the kidney. The hexacanth embryo of the *Tænia echinococcus* reaches the portal circulation by passing through the wall of the stomach or upper part of the small intestine. Dew found the embryo in the portal vein within eight hours of feeding ova to young pigs. The liver is therefore the most frequently infected organ, but owing to the size of the parasite and its mobility, it may pass through the hepatic filter and reach the inferior *vena cava* and so to the right side of the heart and the lungs, which are second to the liver in order of frequency of infection in the human subject. The number of parasites which pass through both the hepatic and pulmonary circulations and reach the general arterial circulation is thus comparatively few. The kidney is infected by way of the arterial circulation, as is the rest of the body, other than the liver and the lungs.

In this case, the primary infection was probably in the upper pole of the left kidney, and not in the perinephric tissues with secondary involvement of the kidney. As the cyst enlarged, slow pressure atrophy of the kidney occurred and the cyst later ruptured into the upper calyx with escape of some of the cyst contents and renal colic as these passed down the ureter.

According to Dew, the formation of daughter cysts, which were very numerous in this case, is probably related to the establishment of a communication with excretory passages (bile ducts in the liver or pelvis in the kidney) when leakage or absorption of fluid occurs. If gross infection is avoided, the inner lining membrane of the cyst reacts by daughter cyst formation. Severe infection of the cyst results in the death of the parasite and degenerative changes often with calcification in its outer fibrous adventitial wall. In this case, a mild degree of infection was present in 1925, seven years before operation, when a few pus cells were found in each low power field of an uncentrifuged specimen of urine; but because of the communication with the pelvis, some escape of cyst contents occurred from time to time with temporary relief of symptoms.

Unless the cyst enlarges sufficiently so as to be palpable or ruptures into the urinary tract, it usually does not produce any symptoms on which its presence can be suspected.

After rupture of the cyst into the renal pelvis has occurred, infection may occur soon, or only after years of attacks of colic. When infection occurs, the symptoms and signs are those of pyonephrosis, and examination of the urine reveals hydatid elements as well as pus.

Regarding treatment, it is necessary to make a complete investigation of the urinary tract and to determine the renal efficiency, and in particular the efficiency of the unaffected kidney because nephrectomy may be necessary.

The usual lumbar approach is advisable with removal of the last rib, which gives good access and provides efficient drainage if this is decided on.

The alternative surgical procedures are: (i) Nephrectomy; (ii) opening the cyst, evacuation of contents and closure without drainage, as was done in this case; (iii) opening of cyst and drainage. Nephrectomy is indicated when multiple cysts are present, or when the greater part of the kidney has been destroyed. It may not be possible, as in this case, where dense adhesions and calcification are present. Closure without drainage after opening the cyst and evacuating its contents can be carried out if gross infection of the cyst contents is not present. If infection in the sac follows, the closed sac may require aspiration or drainage. If the cyst has been completely evacuated and a free communication exists with the renal pelvis, internal drainage may be relied on, as in this case.

Simple evacuation of the contents and drainage carry with it the risk of urinary fistula and infection of the interior from without. They should be reserved for cases in which severe infection is present, when the contents have not been completely evacuated, and if nephrectomy be difficult or impossible to carry out.

Another point of interest in this case is that, although the Casoni intradermal reaction was strongly positive, the hydatid complement deviation test applied to the blood serum gave no reaction either by the warm or ice box method. This is not at all an unusual finding, and the cause of the discrepancy between the two tests has been the subject of much discussion by Dew, Hamilton Fairley and other workers.

Surgery in Other Countries.

[In this column will be published short résumés of articles likely to be of practical value from Journals published in other countries and not readily accessible to surgeons in Australia and New Zealand.]

DAMAGE TO THE SPINAL CORD FOLLOWING SPINAL ANALGESIA AND ITS PREVENTION.

THE element of risk of permanent damage to the spinal cord or its membranes in the course, or following the administration, of a spinal analgesic has been a subject of considerable debate. Some have regarded the untoward effects which have followed the intrathecal injection of an analgesic as due to errors in technique, whilst others have attributed a percentage of these to the irritant action of the analgesic. The fact that spinal analgesia is again enjoying a wide field of employment makes it desirable that any serious after-effects should receive due prominence and critical analysis.

In Number 29, *Munchener Medizinische Wochenschrift*, July 15, 1932, J. Michelsen (of the Neurological Division of the University Clinic of Leipzig) records a series of cases in which damage to the spinal cord followed the administration of a spinal analgesic. Michelsen discusses the probable reasons for such occurrence and suggests preventive measures. The following is a brief outline of Michelsen's cases:

1. A woman, aged twenty-eight years, had a laparotomy for a right ovarian cyst under spinal analgesia. Eight to ten weeks after operation she developed pain in the lower lumbar region, paræsthesia in the calf and increasing weakness in both legs as well as loss of control over the bladder and rectum. Examination disclosed a spastic paresis of the lower extremities, pyramidal tract involvement and sensory disturbances of a posterior root type. Repeated thecal punctures at various lumbar spinal levels did not yield any cerebro-spinal fluid. Temporary improvement was followed by aggravation.

2. A married woman, aged twenty-three years, was operated on under spinal analgesia for a retroflexed uterus. Immediately after the operation she developed incontinence of urine and feeling of weakness in both legs. This was followed

gradually by paralysis and loss of sensation in the lower extremities. When admitted to the clinic, examination showed a spastic paralysis of the legs, pyramidal tract involvement and loss of sensation from the seventh to eighth dorsal segment downwards. The patient subsequently died in her home and no *post mortem* examination was obtained.

3. A woman, aged thirty-seven years, fourteen weeks after an operation for uterine prolapse carried out under spinal analgesia, developed backache, paræsthesia and progressive weakness in both legs. Examination revealed a paraparesis of both lower extremities, increased tendon reflexes and slight sensory disturbances from the groins downwards. Thecal puncture from level of the fifth lumbar to the eighth dorsal vertebra did not yield any cerebro-spinal fluid. Treatment was followed by improvement interrupted by remissions. Thecal puncture two years later was again resultless.

4. A woman, aged forty-nine years, two and a quarter years after an operation for uterine prolapse performed under spinal analgesia, developed a feeling of weakness and rheumatic pains in both legs, occasional basal headache and slight loss of urinary control. Examination disclosed flaccid paresis of both legs, more marked in the right leg, and general diminution of sensation from the costal margin down. Thecal puncture between the fifth lumbar and the fifth dorsal level did not yield any cerebro-spinal fluid. Laminectomy was followed by total paraplegia inferior, retention of urine, bed-sores and death. *Post mortem* examination disclosed a total obliteration of the dural sac, chronic inflammation with enormous thickening of the meninges. There were slight secondary changes in the cord.

5. A woman, aged fifty-seven years, developed, immediately following on spinal analgesia, pain, paræsthesia and sensory disturbances in both legs and loss of control over the bladder and rectum. Improvement occurred after three months, and this was sustained for ten years. After this interval there occurred a marked relapse with sensory and motor disturbances corresponding to the lumbar and sacral segments. A chronic adhesive spinal meningitis was diagnosed, and the patient was submitted to operation. This was followed by temporary improvement, but ultimately death supervened. *Post mortem* examination disclosed a firm and indurated infiltration between the *dura mater* and the epidural tissues and the arachnoid and *pia mater* and between the latter and the spinal cord. In addition, there was found posteriorly between the dura and the cord a space five centimetres long and the diameter of a lead pencil which contained a clear fluid with some fat globules.

Michelsen attributes these after-effects to an irritative spinal meningitis. He contends that such a complication is not an infrequent occurrence, but that milder cases escape observation. He refers to the work of Albo and Pla (*Zeitblatt der Neurologie*, Number 59, 1931). These observers followed up and examined systematically patients who had been operated on under spinal analgesia and found evidence of damage to the pyramidal tracts, the presence of a Babinski reflex, an Oppenheim reflex and foot clonus in patients who did not complain of any subjective or objective disturbances.

Michelsen expresses the opinion that certain predisposing factors favour the occurrence of a post-spinal analgesic meningitis. Amongst such predisposing factors he includes syphilis, influenza, dysentery, furunculosis, rheumatism, tuberculosis as well as infective and traumatic conditions of the vertebræ. Michelsen further considers it essential that the decision to employ spinal analgesia should only follow a complete neurological examination, which should include a cytological and serological investigation of the cerebro-spinal fluid, and where the results of these revealed a normal cerebro-spinal system and fluid. Even where the history, neurological, and other investigations do not disclose any contraindication to the employment of spinal analgesia, Michelsen considers that patients after operation should be kept under careful observation in order to insure early recognition of possible complications with a view to their treatment.

It is a matter for regret that Michelsen's paper omits details regarding the analgesic used, the strength and character of its solution and the method of its administration.

B. T. ZWAR.

A CONTROLLABLE FORM OF SEGMENTAL SPINAL ANALGESIA WHICH ALLOWS OF THE GRADING OF THE DOSAGE ACCORDING TO INDIVIDUAL REQUIREMENTS.

IN Number 14 of *Der Chirurg*, July 15, 1931, Professor Kirschner, who is the Director of the Surgical Clinic in the University of Tübingen, contributes a critical review of the methods of spinal analgesia in general use and details a method for which he claims the advantages outlined in the title.

Kirschner condemns the methods of spinal analgesia which are generally employed for the following reasons:

1. The action of the analgesic when injected into the dural sac cannot be limited to a desired area.
2. The risk of collapse and fall of blood pressure which result from the extensive involvement of vasomotor and blood pressure regulating mechanism of the lower extremities and of the trunk.
3. The fact that the methods of spinal analgesia in general use ignore entirely individual differences, both anatomical and constitutional.

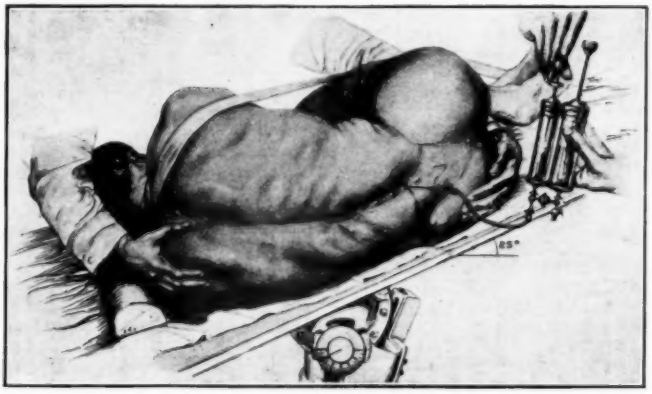

Figure showing Kirschner's apparatus in use.

4. The occurrence of after-effects in the form of headache, paralysis of cranial nerves, nausea and vomiting.

In order to avoid such untoward accompaniments and after-effects, Kirschner aims at the production of a spinal analgesia which answers the following requirements:

1. Is capable of definite limitation in a caudal direction.
2. Is amenable to definite limitation in a cranial direction.
3. Ability to limit the analgesic effect to the spinal segment which supplies the field of operation.
4. Ability to increase the dose of the analgesic from a minimal to the optimal effective one according to individual, constitutional and other requirements.

Kirschner obtains the first of these requirements by the withdrawal of a definite quantity of cerebro-spinal fluid and its replacement by air. During and following this procedure, the patient is kept in an accentuated Trendelenburg position. The amount of cerebro-spinal fluid to be withdrawn and to be replaced depends on the level of the nerve roots supplying the field of operation which it is desired to render analgesic. Finer adjustments of this level can be obtained by the addition or withdrawal of air. If an analgesia for the lower limbs is desired, about 12 cubic centimetres of cerebro-spinal fluid are withdrawn and replaced by air, whilst for one required for an abdominal operation the amount is from

20 to 30 cubic centimetres. The air thus injected into the emptied portion of the dural sac forms a block against a spread caudally of the analgesic solution injected into the sac at the level of junction of the cerebro-spinal fluid and the column of air.

The second requirement, namely, the limitation cranially, Kirschner obtains by the employment of a hypobaric solution (that is one of a specific gravity lighter than that of cerebro-spinal fluid) of "Percaine" in alcohol, dextrine and oil. This solution does not mix with the cerebro-spinal fluid and is not subject to gravitational diffusion; it floats on the surface of the cerebro-spinal fluid and forms a layer between it and the intradural column of air. Kirschner claims that by the addition or the withdrawal of air he is able to adjust the level and area of analgesia as he desires, and is thus able to fulfil the third of the requirements laid down by him.

Kirschner arrives at the dose which is best suited to the needs in each individual case by commencing with the injection of a small or minimal dose, testing the degree of the resulting analgesia and then injecting an additional amount of solution until the required degree of analgesia is obtained.

Kirschner's apparatus consists of a double-barrelled syringe so provided with stop-cocks, rubber tubing, capillary glass tubing and cannula as to allow of the aspiration of cerebro-spinal fluid and its replacement with air by means of one barrel and the injection of the analgesic fluid with the other barrel. The cannula has a lateral opening which allows making the injection of the fluid in a desired direction. The Society of Chemical Industry in Basle (Ciba) supplies the "Percaine" in ampoules.

Kirschner is an enthusiastic advocate of this method and claims that complications and after-effects in the form of collapse, respiratory distress and headaches are much rarer than with other forms of spinal analgesia. He is of opinion that even the presence of myocardial degeneration, arteriosclerosis, icterus, nephritis, peritonitis *et cetera*, is not a contraindication to its use. In conclusion, he stresses the contraindications to the use of "Spinocaine" and the ill-effects which have accompanied or followed its employment.

Experience will tell whether Kirschner's optimism is justified. The method described by him is too complicated to warrant its general employment. Kirschner's advocacy of this form of analgesia raises the question and the doubt whether he is conversant with the modern advances in inhalation anæsthesia which have placed at the surgeon's disposal excellent forms of anæsthesia accompanied or followed by a minimum degree of risk.

B. T. ZWAR.

Reviews.

ANÆSTHESIA.

THE members of the Anæsthetic Staff of the Alfred Hospital, Melbourne, in conjunction with Mr. Balcombe Quick, the Senior Surgeon of the Hospital, have issued a book entitled "Practical Anæsthesia".[1] The book is described as the first of the monographs of the Baker Institute of Medical Research. We give it a hearty welcome. It is fittingly dedicated to the memory of the late Edward Henry Embley, whose researches added much to the knowledge of anæsthesia. Dr. F. H. McMechan, the well-known Secretary-General of the International Anesthesia Research Society, has written a foreword in which he describes the book as a worthy contribution to the campaign of international anæsthesia for the world conquest of pain.

The book is intended as one of instruction for senior students and junior medical officers. It is not intended to be a complete monograph on anæsthesia.

[1] "Monographs of the Baker Institute of Medical Research: Number 1: Practical Anæsthesia", by the Anæsthetic Staff of the Alfred Hospital, Melbourne; 1932. Australia: Australasian Medical Publishing Company, Limited. Demy 8vo., pp. 249, with illustrations. Price: 10s. 6d. net.

Little attention has been paid to anæsthetic agents and techniques unlikely to be encountered by the house officer during his term of service or in his early years of general practice. Since most medical practitioners will in their later years of practice continue to use methods which have proved safe and reliable in their hospital practice and in their early experience in general practice, this book may safely be taken as a useful practical guide to practitioners. The contributors from the anæsthetic staff are seven in number; the sections contributed by each member of the staff have not been specified. The editor, Dr. Geoffrey Kaye, must be congratulated on having produced a volume of uniform style and devoid of overlapping.

The subjects have been discussed in logical sequence, though we should have preferred to have seen the chapter on accidents and sequelæ of anæsthesia placed after instead of before those on endotracheal anæsthesia, spinal anæsthesia, local anæsthesia and basal narcosis. The opening chapters on the assessment of anæsthetic risk and the choice of an anæsthetic should be studied by all medical practitioners. Though many surgeons are in the habit of leaving the choice of anæsthetic agents to their anæsthetists, they will find these two chapters of great value. In this connexion we may quote a statement from the first chapter: "Most surgeons are coming to realize that the anæsthetist is not so much a necessary evil as a helpful collaborator and an essential part of the operating team." The chapters on ethyl chloride, on ether and on chloroform are among the best in the book. The chapter on basal narcosis is short, but adequate. We cannot but approve of the conservative attitude adopted: "Basal narcosis has no direct indications *per se*. It is really an extension of the principle of pre-anæsthetic sedation, . ." One of the most valuable parts of the book is that in which deaths under anæsthesia are discussed. The one chapter in which we think more detail might with advantage have been given is that dealing with local anæsthesia. The index is satisfactory, and the printing and binding are all that might be desired.

From this short account of the book it will be clear that the volume may be looked upon as one likely to satisfy a definite need in Australian and New Zealand medicine. We recommend it with confidence.

A BOOK ON ORTHOPÆDIC SURGERY.

"ORTHOPÆDIC SURGERY", by Walter Mercer, is described by the author as an "attempt to give a comprehensive survey of the subject, including the latest work and on occasion the expression of personal opinion".[1]

At the outset he plays a graceful tribute to the "Spurgeons of his profession" and it is easy to trace their influence through the work. A critical examination of the book reveals an exceedingly complete summary of the many advances in orthopædic surgery which have been published in the past five years. But it is much more than a summary. The judicious selection of material from contemporaries on the Continent and in America is well exemplified by the presentation of Schmorl's work on the pathology of the intervertebral disks, Gruta's classification of the various types of *myositis ossificans* and of Rich's work on the pathology of tuberculous spondylitis.

The author draws on a very extensive personal experience for the section on tuberculosis of bones and joints, and it is by no means the least impressive part of the work. He obviously thinks in terms of the "pathology of the living" and endeavours to explain signs and symptoms on this basis. He exhibits a wise conservatism in his outlook, which is, however, tinctured with the more radical tendency of other schools when, for example, he suggests that arthroplasty may be of value in certain selected cases of ankylosis in tuberculous joints. He would

[1] "Orthopædic Surgery", by Walter Mercer, M.B., Ch.B., F.R.C.S., F.R.S.; 1932. London: Edward Arnold and Company. Royal 8vo., pp. 706, with illustrations. Price: 32s. 6d. net.

probably find himself in conflict with many surgeons when he advocates the treatment of carbuncles by "cruciate incisions extending well beyond the indurated area into normal tissue", and also where he describes an "infection of the fibrous tissue of muscle sheaths . . . . known in its acute form as lumbago and in its chronic stage as fibrositis". The chapter on infections of the hand emphasizes the best teaching on this difficult subject and is worthy of study. The complications of fractures are treated in a masterly fashion. The author expresses a preference for autogenous grafts of the massive inlay type where a bone graft becomes necessary. He shares the satisfaction of many other surgeons with the results of treating osteomyelitis and compound fractures by the "closed method" of Winnett Orr, but maintains the value of Carrel-Dakin treatment in selected cases.

Bone tumours are discussed in the light of the classification suggested by Fraser, which is based on the cells from which the various tumours arise. One chapter is devoted to affections of epiphyses and is a very complete abstract of the authoritative work on this branch of the subject. The vexed question of arthritis receives very careful treatment, and again embraces the best work on the pathology and treatment of this condition. The theory that the pathological basis of this condition is a vasoconstriction receives attention, and the essential similarity of the early lesions in osteoarthritis and rheumatoid arthritis is discussed.

The various affections of the spine include an excellent discussion of the subject of low backache and a classification of the spinal errors of middle and old age, which are considered by Schmorl to be different manifestations of a single process—that of senile degeneration. The changes hitherto known as *spondylitis deformans* are now grouped under the term "*spondylosis deformans*", and "von Bechterew's disease" is reserved for the condition where ankylosis of the column is due to changes in the intervertebral articulations.

The various operative procedures are clearly described, but we cannot concede that the "detail is sufficient to enable the young surgeon to perform them with confidence", nor would we feel justified in expecting it. We do, however, regret that the demands of space have prevented a more detailed description by one who is obviously a master of his subject.

The book is profusely illustrated, and this forms a valuable feature of the work; the process work is of a very high order, and a bibliography enables easy access to more detailed discussions of the various monographs. We would recommend the book to the serious attention of the student, the post-graduate and the practising surgeon, but it should be studiously avoided unless one has some hours to spare: it will certainly hold one's attention and result in the neglect of other work.

Proceedings of the Royal Australasian College of Surgeons

NEW ZEALAND MEETING.

THE annual general meeting of the New Zealand Fellows of the Royal Australasian College of Surgeons was held at Wellington on September 8, 1932, SIR LOUIS BARNETT in the chair.

In his opening remarks, Sir Louis Barnett pointed out that in Australia every opportunity was given for New Zealand Fellows to attend post-graduate work, which was of a very high standard. He also described the recent activities of the College in Australia.

The Hospital Committee reported that it had arranged for a deputation to wait on the Hospital Board's Conference. This deputation had outlined the principles of the Royal Australasian College of Surgeons, with special reference to the training of surgeons. The deputation had secured the attention of the Conference, was listened to with interest, and it was hoped that some results would accrue.

The following motions were proposed and seconded and carried:

That in the opinion of the New Zealand Section of the Royal Australasian College of Surgeons the surgical staffing of the so-called "closed" or "one-man" hospitals in certain of the larger centres, such as Invercargill, Ashburton, Hamilton and Gisborne, suffers from serious defects which lessen the efficiency of these institutions as compared with hospitals that have a properly organized visiting staff. The College, therefore, strongly advocates the adoption of the visiting staff system.

That a copy of this resolution be sent to the Honourable the Minister of Health, with explanatory comments, and copies to the Director-General of Health and the Chairman of Boards, and Medical Superintendents of the Hospitals at Invercargill, Ashburton, Hamilton and Gisborne, for their information.

That this College approach the Director-General of Health with a view to assisting him in a reclassification and grading of hospitals and submitting an adequate system of surgical staffing, and that for this purpose a committee be appointed consisting of the present Hospital Committee with power to add to its number.

The Report of the Hydatid Research Committee was presented, and it was decided that as this was a committee of the whole College, although its headquarters were in New Zealand, reports should not be asked for by the Dominion Section in future.

It was suggested by F. Gordon Bell that the only way in which Fellows of the College could assist in promoting an improvement in neurological surgery would be for those on the staffs of the main hospitals to agree to a segregation of cases in their hospitals, and to be prepared to give younger men who had properly trained themselves for this work opportunity of doing it and so insuring a succession from senior to junior as time went on.

Papers and Discussions.

Short papers, each author being restricted to ten minutes, were read as follows: R. Campbell Begg: "Renal Tuberculosis: The Question of the Second Kidney"; E. L. Marchant: "Infections of the Orbit"; H. Hardwick-Smith: "Some Practical Points in Thyreoid Surgery"; A. Gillies: "The Reconstruction of the Paralytic Foot"; L. D. Cohen: "Points in Mastoid Surgery"; E. Gordon Anderson: "Some Points in the Treatment of Rectal Carcinoma". Some of these papers will be published in later issues of the journal.

Cases were demonstrated by H. Hardwick-Smith, W. J. Hope-Robertson, A. Gillies, D. Macdonald Wilson, T. D. M. Stout, H. K. Corkill, R. C. Begg, D. Whyte.

In a discussion of the surgery of cerebral and spinal tumours the following took part and showed specimens: Sir Carrick Robertson: "Diagnosis of Cerebral Tumours"; Harold Corkill: "Pre-Operative and Post-Operative Management in Cerebral Surgery"; Hope-Robertson: "The Special Senses in Relation to the Diagnosis of Cerebral Tumours"; L. D. Cohen: "Early Cerebral Signs Arising from Extension of Disease from the Middle Ear *et cetera*". Demonstrations were given on the method of treatment of malignant disease by radium.

POST-GRADUATE TRAVEL BUREAU.

ARRANGEMENTS have been made for the establishment of a post-graduate travel bureau at the College office. This bureau will accumulate information about post-graduate surgical education overseas. It will arrange to introduce suitable graduates to the various overseas surgical clinics, and will endeavour to have some surgical posts at its disposal. The bureau, which will be further developed in the proposed new Headquarters, will serve as a liaison office, particularly between Australia and New Zealand and surgical clinics of the British Empire. Mr. J. M. Buchanan, Junior, will be in charge of the bureau.